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Technology Review

Edited at the Massachusetts Institute of Technology

ENERGY AND THE AUTOMOBILE

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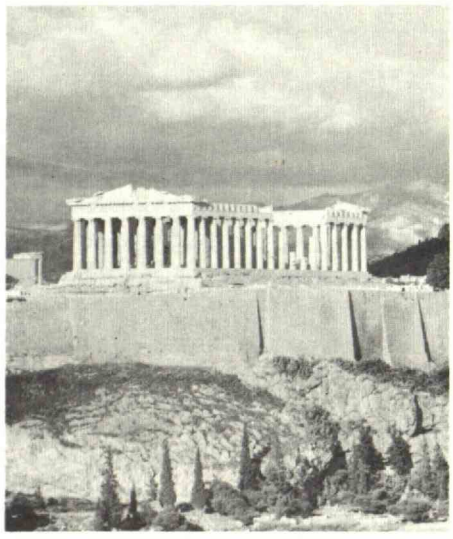

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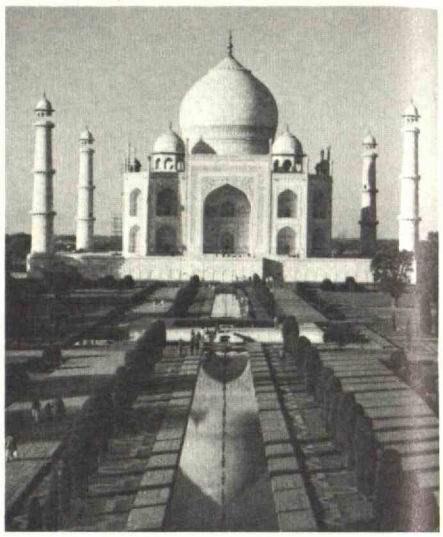

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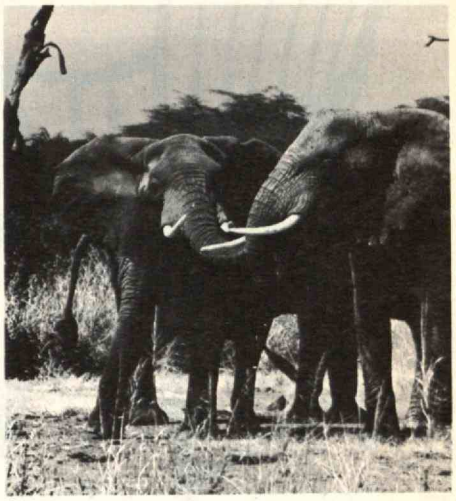

PARK; the spectacular masses of pink flamingos at LAKE NAKURU; black-maned lions and multitudes of plains game in MASAI-MARA RESERVE; the vast stretches of the SERENGETI PLAINS, with leopard, cheetah and large prides of lions, as well as great herds of zebra, wildebeest, and impala; the permanent concentrations of wildlife on the floor of the NGORONGORO CRATER; tree-climbing lions and herds of elephant along the shores of LAKE MANYARA; and the beaches and tropical splendor of historic MOMBASA on the Indian Ocean, with its colorful old Arab quarter and great 16th century Portuguese fort, and with optional excursions to LAMU or ZANZIBAR. The program also includes a visit to the famous excavations at OLDUVAI GORGE and special opportunities to see tribal dancing and the way of life of the Kikuyu and Masai tribes, as well as the great safari capital of NAIROBI. Optional post-tour extensions are also available to ETHIOPIA and the VICTORIA FALLS. Total cost is $2100 from New York. Departures in January, February, March, May, June, July, August, September, October, November and December 1975.

* * *

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Technology Review

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Articles

Departments

The First Line

Editor's Publisher

Though his name leads the masthead, the Publisher of a magazine is little known to its readers; indeed, he typically maintains a profile so low as to make him anonymous. Yet his influence is pervasive — the Editor's mentor, the Advertising Manager's partner, the Circulation Manager's conscience . . . the engineer of the resources which assure the editors — and their readers — the remarkable privileges they enjoy.

Careful observers of our masthead will note that *Technology Review* now has a new Publisher; hence the Editor's use of this space for a brief note about Donald P. Severance, who has joined the M.I.T. administrative staff after having been (until January 1) Publisher of the *Review* throughout my tenure as Editor. No editor could have asked for a more thoughtful, generous, and judicious associate; only other editors, perhaps, will understand my full intention when I write that Mr. Severance was always — and in every way — an editor's publisher. —*J.M.*

Letters

When Is "Oversize" Too Big?

I question Michael Chiusano's statement *(see "Conserving Transport Energy: Pennies and Nickels," June, pp. 54-55)* that A. C. Malliaris "applied some commonsense assumptions . . ."

This writer presented some commonsense facts at the opening session of the Urban Vehicle Design Competition Symposium in 1973: Approximately 90 per cent of the automobiles in use in the U.S. on an average week day accumulate no more than 40 miles of travel. This local "running around" is done with an average occupancy of 1.2 to 1.3 persons per vehicle, and the vehicle requires an average of about 16 h.p. for propulsion. (Today's power steering systems need another 5 h.p. just to drive the hydraulic pump.)

These travel characteristics indicate that, without changing current driving habits, 90 per cent of the passenger cars on the road today could well afford to be 1600-to-1800-lb. vehicles of 1200-cc. (or less) piston displacement, with fuel performance of 30 (or more) m.p.g.

Had the U.S. passenger vehicle "population" been as I prescribe, we might not have had to import a drop of oil in 1972. I don't exactly disagree with the statement by Malliaris in the final paragraph, but "oversize" doesn't have to be as badly disproportionate as the Detroit bunch would have us believe.

Morton I. Weinberg
Buffalo, N.Y.

A Perspective on Salt

Ian Nisbet states *(May, pp. 6-7)* that the number of traffic deaths on icy roads in the United States was the same in 1972 as in 1950, despite a 15-fold increase in salt use. This statistic, as stated, is meaningless to the reader since we are not told of the traffic increase (or decrease). Deaths per passenger mile, for example, would give a more accurate perspective.

Robert E. Bernert
South Dartmouth, Mass.

Dr. Nisbet responds:

A rigorous statistical study of traffic accidents would indeed have to take into account traffic densities, and also changes in such other factors as road design, automobile safety devices, tires, lighting, and driver behavior. My point was that the contribution of salting to road safety is not self-evident, as some would have us believe: The studies presented as evidence to date are not rigorous in the above sense, and they do not even show convincingly whether the contribution is positive or negative.

The Price of Power

Your continuing coverage of our energy "crisis" suggests that your readers may be interested in the following quantitative analysis of the constituents of electric utility power generating costs.

A modern electric power plant converts approximately 38 per cent of its fossil fuel energy into electric energy. For example, one ton of 25-million-B.t.u. coal produces 2.778 Kwh.; a barrel of 6-million-B.t.u. oil produces 667 Kwh. Coal at $12.50/ton is the equivalent of oil at $3/bbl., since each fuel produces electric energy for a fuel cost of 4.5 mills/Kwh.

To build the modern large fossil-fueled power plant costs approximately $200/Kwh., which, amortized (interest plus depreciation) at 15 per cent/year with an operating load factor of 70 per cent, gives a capital cost of 5 mills/Kwh. With plant operating personnel at 5 mills/Kwh., the total energy cost at the buss is 10 mills (1 cent)/Kwh.

Since fuel cost represents approximately 45 per cent of the total cost, a 50-per-cent fuel cost rise ($18.75/ton of coal or $4.50/bbl. of oil) increases total energy cost 22.5 per cent, to 1.225 cents/Kwh. Doubling fuel cost ($25/ton or $6/bbl.) increases total cost by 45 per cent, to 1.45 cents/Kwh. Tripling fuel cost ($37.50/ton or $9/bbl.) effects a 90-per-cent cost increase to 1.9 cents/Kwh. Quadrupling the cost of fuel ($50/ton or $12/bbl.), as the Arabs have done, increases cost 135 per cent to 2.35 cents/Kwh.

My advice to utility commission members and consumers is to keep these figures in mind when evaluating the merits of rate hikes or fuel cost surcharges.

Raymond Mancha
Winter Park, Fla.

The (Ir)rationality of Fault Trees

It is curious how the technological establishment subjects studies critical of itself to devastating scrutiny while accepting at face value anything which bolsters its continued existence or reputation. I refer, of course, to your report of the much-touted Rasmussen report *(Oct./Nov., pp. 14-15)*; your reviewer could hardly contain his glee at the conclusions of this report. However, had any of your staff subjected the report to even a hasty glance they would have come up with some quite glaring faults which I and others have pointed out. Some of them are:

— Since a fault tree is inherently subjective, there is no possible way of knowing whether one branch (e.g., a locus of potential failure) has been omitted. One omission could invalidate the whole tree. William Bryan of the National Institute for Applied Research told the California State Assembly's Subcommittee on State Energy Policy in February, 1974, that the numbers (fault rates) in fault trees are totally meaningless because judgments are made at every point and because the tree is subject to manipulation.

— There is no way of factoring in potential human error or malice. Even if every mode of mechanical failure had been included (which is patently impossible), there is no way of predicting whether or when an operator or terrorist will commit an error or act of malevolence.

— The Rasmussen report deals only with the odds against catastrophic accidents arising from reactor malfunction. It does not deal with the possibility of accidents arising during other parts of the fuel cycle — fuel rod fabrication, waste transport and storage, and spent fuel reprocessing.

— The Rasmussen report, like the old 1957 Brookhaven report, is outdated already because it deals with effects from small reactors up to 800 Mw. Since we have had only one year's experience with reactors larger than this (which by their very size greatly increase risks and complicate safety problems), the Rasmussen report is inapplicable.

Lorna Salzman
New York, N.Y.

The writer is Local Issues Chairwoman of Friends of the Earth, N.Y.C. – Ed.

Priorities for Generalists

Stuart Chase *("A Generalist's Manifesto for the Years to 1984," July/Aug., p. 13)* appears to feel we are to return to the age of barter. If we are, we will go back more than 200 years, perhaps more than 2,000. Money, or what was used as money, was after all developed to obviate the necessity for person-to-person barter. Each unit represented a fixed number of man-hours of labor which could be traded for its equivalent in goods or services. Heaven forbid that we should revisit that earlier era.

Chase states that technology$_1$ is obvi-

ously not equal to technology$_2$, with which I agree. How then can he make personnel$_1$ equal to personnel$_2$? Am I to understand that he feels that a highly trained nuclear reactor operator the equivalent of a bricklayer? That seems to be the sense of his remarks about reduction of the military and the use to which the displaced personnel may be put. His whole paragraph relating to the reduction of the military is nonsense on the face of it. One gathers that a generalist cannot be expected to know much about the defense of the nation whose freedoms he enjoys. His reference to a nuclear physicist as his source of wisdom makes about as much sense as the rest of his paragraph.

As to his idea of an all-powerful Office of Technology Assessment, we are all well aware of the fate of many outstanding scientific findings in the past. How many deaths occurred because of the refusal to recognize the achievements of a Lister? Who believed the Wright brothers? When I signed the contract for the research and development that led to the first aircraft gas turbine produced in this country, I had on my desk a study report from a committee of eminent scientists stating that the aircraft gas turbine was impossible. The internal combustion engine will be in use long after Mr. Chase and I are dead and forgotten. And in automotive equipment, too.

It does not take a generalist to determine that there are many things that could and should be done to make the world a better place to live in. Any person of feeling and common sense can prepare a list. Establishing the priority for the things to be done, however, requires a specialist who can analyze the problems, postulate the solutions and compare these solutions to the needs of all the other parts of the jigsaw puzzle that make up modern civilization.

Selden B. Spangler
Paradise Valley, Ariz.

Accentuating the Negative

In David F. Salisbury's report on reactor safety (*Oct./Nov., pp. 14-15*), the probabilities of reactor failure are given as 5×10^6 per reactor-year, 3×10^4 per reactor-year, etc. Should you not prefix the exponents with a minus sign?

V. E. MacDonell
Somers, Mont.

Indeed. It is the editors' error, and we apologize for failing to accentuate the positive. The correct numbers are 5×10^{-6}, 3×10^{-4}, etc. — *Ed.*

What To Do with "Windfall" Profits

Professor Lester C. Thurow (*see "The Economics of the Energy Crisis," March/April, 1974, pp. 48-59*) feels that, through taxation, the price of oil from existing production should be frozen at current levels, in order to prevent "windfall" profits from accruing to the oil companies. He reasons that these "windfall" profits will not encourage new production and therefore are neither necessary nor desirable.

As an individual with some minor oil interests but a major interest in providing a college education to three children, I feel that the professor has his eye on the wrong ball. The continuously escalating tuition costs of college education concern me a great deal more than a few pennies more per gallon at the gasoline pump.

Fortunately, Professor Thurow's solution is applicable. We should freeze the salaries paid college professors, because salaries are a large part of the cost of education. Since the professors have already made an investment in their education and a career commitment of many years standing, the vast majority will find it in their best economic interest to stay and continue to produce graduates. The ones most likely to leave would be those who feel they are being exploited. Nothing, however, could be farther from the truth, for we are only trying to protect ourselves from being exploited by rapacious professors making a "windfall" profit from the shortage of professorial talent. Since professors are trained by professors, the shortage must be contrived. Thus all the more reason for our taking legal action to protect ourselves.

Now I recognize that if we freeze professors' pay levels there would be little incentive for students to enter the teaching field. This is easily solved by using our oil industry experience. We will not freeze the salaries of those who enter the field after June, 1974, and thus continue to provide an incentive for youth to enter the field. That some might earn more than more qualified members of the older group is of no concern to us, since holding down the cost of education is our objective.

After a little reflection, another problem becomes apparent. Those professors who turn 65 might choose to retire rather than continue teaching on a part-time basis. This would tend to increase our professorial shortage. Again, our oil experience provides us with the answer. We will designate as "stripper professors" those who work less than 10 bbl./day (pardon me, I mean 10 hr./wk.). They also will be decontrolled and allowed to negotiate their own compensation. Thus this group will not be lost to the work force.

While a frozen pay level for professors might work a small hardship on them, think of the advantages to society. If they found their standard of living disadvantageous, they might teach an extra course to earn an extra dollar. Thus the program will actually stimulate professorial output, which is our objective.

While this program happens to be of great benefit to me, and probably to more of society than it hurts, it has still another great social advantage. The marginal corporate income tax rate is 48 per cent. Thus, 48 per cent of the "windfall" profits of the oil companies accrue to the federal government. I don't know the tax bracket of the average professor but I doubt if it is that high. Thus, if professorial salaries are allowed to rise, less of the "windfall" profits will accrue to the government and, therefore, to society as a whole.

While it might be agreed that Professor Thurow proposes taxing "windfall" profits while I attack earned profits, this is merely semantics representing a difference in point of view. The shortage of crude has been perceived by some for several years, and investments have been made on the assumption of increased crude prices. Thus, I submit, a "windfall" profit is a profit made by someone who sees things before I do, while an earned profit is made by one who sees things when or after I do. Hardly a definition on which to base our taxing policy.

Clearly if Professor Thurow's program is good, mine is even better. I look forward to his avid support of my program now that he has seen its merits.

Jack C. Page
Dallas, Texas

Professor Thurow responds:

If two or three "middle eastern" college professors joined together in a cartel and managed to triple the wages of college professors by cutting back on their exports of cheap (10 cents/bbl.) knowledge,

Letters continued on p. 68

Science at the Center of the Israeli Stage

National Report
by
Victor Cohn

The President, for the second time in Israel's 26 years, is a scientist. Ephraim Katzir was, until 1973 an active worker at the Weizmann Institute of Science, one of the world's great graduate universities.

Israel's first scientist-President was the father of the country, Chaim Weizmann. In 1918, while General Edmund H. H. Allenby was still fighting, he also founded and laid the first stone of the Hebrew University on Mount Scopus. In 1934 he founded the laboratories that were to become the Weizmann Institute. He said, "Science will bring to this land both peace and a renewal of its youth, creating here the springs of a new spiritual and material life."

Dr. Weizmann himself was an intensely practical applier of science. Born in a Russian *shtetl,* or ghetto-village, cut off from other education, he was fortunate in having a *cheder* or religious school teacher who defied pinched tradition to teach him some natural science and chemistry. He went on to study in Pinsk, Berlin, and Freiburg; and then, choosing life in freer Britain, he went to Manchester in 1906.

He wrote, "I brought out of Russia a dread of the 'eternal student' type, of the unpractical idealist without roots in the worldly struggle." A child of Eastern Europe's pogroms and persecution, Weizmann sought such roots in Zion.

And he worked on what was then the forefront of science, when organic chemists occupied a role later filled by nuclear physicists and, still later, by molecular biologists. He was a scientific child of Pasteur, studying the biology and bacteriology of fermentation and the reordering of molecules by natural and man-made means.

Working on a natural rubber substitute, Weizmann learned to make isoprene and polymerize it into a rubber-like material. One intermediate product was acetone, converted by bacteria from sugar and starch through fermentation.

In 1915 Weizmann was approached by Lloyd George, then Minister of Munitions, and Winston Churchill, First Lord of the Admiralty. Cordite, the new smokeless-powder nitroglycerine propellant that served British dreadnaughts and artillery, was in dangerously short supply for lack of acetone, the essential solvent to produce this most powerful explosive of the day.

Weizmann was asked if he could manufacture acetone by the thousands of tons. He said he had made only a bit but believed expansion was possible. Working in an Admiralty laboratory he established close relations with Lloyd George, Churchill, and Churchill's Admiralty successor, Arthur James Balfour.

Weizmann talked science and his other great passion, Zionism, to them. In July, 1917, he and Zionist colleagues submitted a proposed statement on Palestine to Lloyd George, by now Prime Minister, and Balfour, now Foreign Minister. Modified and then approved by American President Wilson on November 2, 1917, this became the British "Balfour Declaration" and later League of Nations policy supporting "a national home for the Jewish people" in Palestine.

Lloyd George later called the Declaration Weizmann's reward, saying Weizmann had "put the country substantially in his debt" by averting a disastrous munitions shortage. In fact, the British government considered many elements of policy before making the statement, as one among many Allied statements supporting this and that national aspiration.

Still, Weizmann and his science played an essential role in the statement's gestation. Chaim Weizmann thus injected not only science but practical science, and not only practical science but science for defense, into Israel's foundation.

"Within a Reasonable Period of Time"

It is not surprising, then, to learn today that about half of the country's research and development is military — the same proportion holds in another defense-possessed nation, the United States — and that half of Israel's 6,000 scientists and research engineers work on defense projects.

"I would say our technological ability to produce many of our own weapon systems is a decisive factor in our strength," Professor (and Reserve General) Yitzchak Yaakov told me in an interview; Dr. Yaakov was Chief Scientist of the Ministry of Commerce and is now Chief Defense Scientist. He and others told of the Gabriel sea-to-sea missile ("It destroyed the missile boats of the Russians — I mean the Egyptians and Syrians," said Professor Eliezer Tal, Head of the National Council for Research and Development); the Shafrir air-to-air missile; electronic systems for missile control, communications, and counter-measures; and the rebuilding of imported and captured tanks with new guns, engines and other systems to "compete successfully with the most advanced Russian tanks" (according to Dr. Yaakov, who for some years directed tank modification).

There is also a new, not-much-talked-about Jericho ground-to-ground missile, said to have a range of close to 300 miles, to serve as a counter-threat to the Soviet Scud ground-to-ground missiles in Egyptian hands. The fate of Israeli cities is much on the mind of Israel's techno-military men when they talk about another war.

Israeli defense was obviously on President Katzir's mind when he greeted visiting American and European science reporters on the night of December 1. He talked mainly of the drive for learning and peaceful nation-building. But "as a biophysicist and biochemist," he volunteered, "I spent many years in the Ministry of Defense."

Then, freely answering questions, he said some blunt things no important Israeli official had said before: Israel "has the potential," the "know-how" to make atomic weapons and "if we need it we will do it," and it can be done "within a reasonable period of time." Israel did "not" have such bombs, and would not be the first to "introduce" such weapons into the area, but had developed its know-how through "research" — which, in the context of Katzir's remarks, seemed to imply bench-work on components.

Israel has a French-built 26-Mw. research reactor which (says simple calculation) could produce enough plutonium each year for one or two small bombs. U.S. military observers believe Soviet ships carried atomic warheads for Scud

missiles into Egypt's port of Alexandria during the Yom Kippur War. Under such pressure, increasing guerrilla attacks and deteriorating prospects for peace, President Katzir seemed to be saying, Don't tread on us.

The editor of Egypt's semi-official newspaper, *Al Ahram,* promptly replied that the Arab world needed to build, buy, or borrow nuclear weapons as a deterrant to Israel. The possible scale of Middle East war had obviously escalated, not by Katzir's or Al Ahram's words but by the facts of technology and lack of peace.

Israeli scientists talk with no more glee than American scientists of their nation's preoccupation with technological weaponry and their science's captive role in techno-politics. Chaim Weizmann, Dr. Katzir recalled recently, was himself "less than enthusiastic about the diversion of scientific energy to war work" in his young Israel. Still, as scientist and politician, he helped found this precarious country.

A story, maybe apocryphal, tells of the aged Weizmann watching while soldiers with dogs guarded his residence during his new state's first years.

"When I was young," he is said to have mused, "soldiers with dogs attacked Jews." Now they guard the Jews. Can Jews have changed? No, dogs must have changed."

Has science changed? No, in Israel and elsewhere it has only stayed the same, sadly.

Victor Cohn, formerly its Science Editor, now reports on major science-oriented affairs for the Washington Post. *This is the first of two reports stemming from a recent trip to Israel during which Mr. Cohn was the guest of Israeli universities as a co-organizaer of an international science writers' tour of that country's scientific facilities.*

The Monitor Is Found!

Special Report
by
Harold E. Edgerton

Many ships have been lost at sea without a trace. Not so with the famous Civil War ship *U.S.S. Monitor,* which sank under tow off Cape Hatteras, N.C., during a stormy December night in 1862. Extensive ship logs and legal testimony as well as many personal stories from the captain and crew are available; one of the most valuable set of records came from the log and crew of the side-wheeler *Rhode Island,* which had the *Monitor* under tow at the time she was lost.

Why has it taken so long to find the *Monitor* with so much information available to all who searched? Because it is difficult to find *anything* in the ocean, and because Cape Hatteras is one of the worst places in the ocean to have a wreck. The charts show a large, blank area with a legend: "Hydrography is not charted on Diamond Shoals due to the changeable nature of the area. Navigation in the area is extremely hazardous to all types of craft."

It is here that the ocean current from the North meets the Gulf Stream from the South, with all sorts of complications caused by tidal effects and wind. The exact position of the sinking as recorded by the officers of the *Monitor* and the *Rhode Island* is bound to be inaccurate, because of the limited observations they could make. It was at night, during a storm; they had neither loran nor radar. Indeed, I must compliment them on their dead reckoning under those conditions.

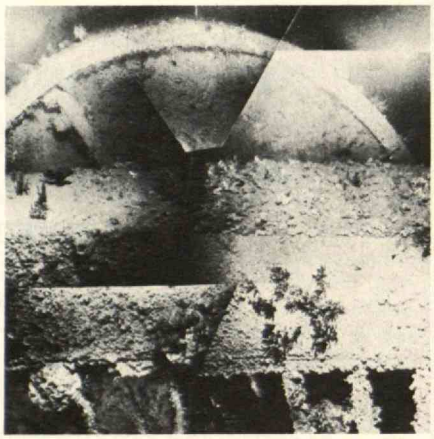
Dorothy Nicholson of the National Geographic Society has a card file of some 700 wrecks in the Cape Hatteras area. The marine charts are sprinkled with "WR" signs and small marks that appear like fish skeletons. No surprise, then, that stories have periodically appeared about finding the lost *Monitor.* One of the earliest was a report from a family picnicking on a beach. During an exceptionally low tide, they said, a round steel object was exposed at the sea's surface; was it the *Monitor*'s turret? No one has reported seeing it since. Repeatedly newspapers have carried accounts of another finding of the *Monitor,* followed by other accounts of the losing of the site and ultimately the failure to refind the wreck.

My experiences with underwater photography and sonar equipment gave me an appreciation of the search problem. It seemed to me that side-scan sonar, an excellent technique for exploring large areas for objects that project up out of the bottom, was the method to employ. The side-scan sonar sends out narrow beams (only a few degrees wide) in both directions perpendicular to the ship on which it is mounted. The beams are 50° in the vertical dimension, so echoes are received from the bottom at all distances from directly beneath the instrument out to 250 m. or more. The echoes along these perpendicular directions, both left and right, are printed on a recorder as the ship proceeds.

Thus a large area is searched. For example, the two beams can cover an area 400 m. or more wide. If the ship proceeds at 4 knots, the area covered per hour is slightly more than a square mile.

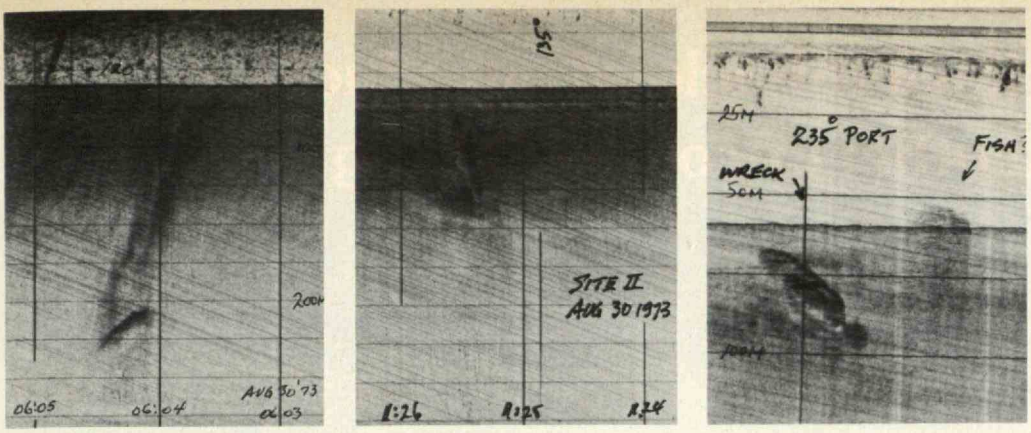
The best estimates placed the *Monitor* wreck in an area six mi. wide by 16 mi. long; therefore, 96 mi.^{2} should be searched, requiring 96 hours of operation if no overlap is needed. But that is obviously too simple: Anyone who has been to sea is aware of the difficulties of knowing where a ship is located and of making it go exactly where one wants it to go.

But what if the wreck is completely



A vertical mosaic picture above, made from many photographs from the *Alcoa Seaprobe*, shows the *Monitor*'s turret in 220 ft. of water some 16 mi. off Cape Hatteras. The ship apparently turned over, the turret fell off, and the ship settled upon it. Note that the bottom plates of the ship are completely missing from the ribs. Horizontal photographs might reveal if the two 11-in. guns are still in the turret. A complete mosaic of the entire wreck — the photographs used above are included — appeared in *National Geographic* for January.

The camera-strobe system shown at the left is now lying in the wreck of the *Monitor* 16 mi. off Cape Hatteras, full of exposed film. The picture shows it being prepared for a descent during the August, 1973, expedition which confirmed the location of the wreck; the author describes how the equipment was later lost.



These three side-scan sonar "pictures" of the *Monitor* wreck are typical of those made by the author and his associates in August, 1973. From such records as these it was determined that the wreck lies almost due east and west with the bow to the west. A scour, caused by the current, can be detected in some pictures 300 m. from the wreck.

covered with sand and cannot be seen by side-scan sonar? A bottom-penetration sonar can cover at best only strips about 50 ft. wide in 200 ft. of water. A tedious search pattern would have to be carefully established, and the search time would be greater by 24 times. Instead of 96 days, the search would take 2,300 days, or even longer if precise navigation could not be assured.

I concluded in 1972 that these technical search equipments should give us the means to find the *Monitor*. This was my goal; so I got busy with plans to find support and help.

63,100 ft. From Diamond Shoals

An appeal to John Newton, Marine Superintendent of the Oceanographic Program, Duke University Marine Laboratory, Beaufort, N.C., struck a resonant note. He, too, had *Monitor* fever. We met for the first time in January, 1973, while I was on a side-scan sonar expedition out of San Juan, P.R. We struck it off immediately and began to plan for a serious search. He would organize a ship and crew; my job would be to bring a side-scan sonar and support equipment. August was selected as the best time of the year. A proposal to the Research Committee of the National Geographic Society for a grant in aid was immediately approved. The *R/V Eastward* was at our disposal for part of its August, 1973, cruise off Cape Hatteras.

Meanwhile, I had accumulated several others who wanted to find the *Monitor*. One was Ed Jaeckel of Ridgefield, Conn. We had discussed small-scale expeditions using small boats and sonar equipment close to shore. Fortunately for us we never got beyond the discussion stage since the *Monitor* is 16 miles offshore. Ed was acquainted with the del Norte navigation system which could plot our position very accurately. The del Norte organization furnished the equipment to us, and under Ed's management it proved to be very useful.

Fred Feyling, who has accompanied me to Greece on several underwater archaeological expeditions, was eager to go with us. He has a keen ability for navigation, map construction, data recording, etc. We also recruited Robert Sheridan, a geologist at the University of Delaware, and Gordon Watts, archaeologist with the State of North Carolina, as principal investigators with Dr. Newton. Numerous others assisted in many ways.

It was Fred Feyling who located our first target with the side-scan sonar during a midnight watch on August 23, 1973. Excitement was high.

Unfortunately, several days of photography and television "looking" convinced us that the round pilot house of the sunken fishing ship was not the *Monitor's* turret. This wreck is 90 to 96 m. deep, 81,990 ft. from Diamond Shoals Light as read on the del Norte device.

Our search then continued closer to Diamond Shoals Light. My side-scan sonar equipment quit. We continued with the regular vertical sonar and an adjustable-angle Simrad "Fish Finder" sonar that could be directed toward the side as a side-looking type. This sonar picked up our second target. Fred Kelly gets the credit for being alert and shouting "target." Soon we had the depth (220 ft.) and distance to Diamond Shoals Light (63,100 ft.).

Next came the camera. The pictures on the first roll showed promise. So we sent the camera down again. But on the last exposure the camera became entwined in the wreck. It would not come up. A surge of the ship caused the steel cable to break; the camera, strobe, and a pinger were left in the wreck. As I write this in November, 1974, the equipment is still there; but it is our hope to retrieve this camera and develop that exposed film!

A television was then lowered cautiously while those on deck crowded around the receiver. What a shout went up when we recognized the turret! But it was underneath the ship, half covered. Why? Eventually we came to realize that the ship was upside down; the turret had fallen away and the ship landed on top of it. The bottom of the *Monitor* had collapsed. Fortunately, the turret was only half covered by the heavy armor plate, so we could estimate its diameter and wall thickness. A complete study and report of the television tapes were made by Gordon Watts.

I should point out that we took the photographs and television tapes with the *Eastward* anchored up-current at the right distance. The engines were used to move the ship back and forth. These maneuvers were difficult to achieve. Conditions were often not right, and many times we had to start over again.

While all this was going on, the side-scan sonar had been partially repaired and could be used on one side; so we made a series of side-scan sonar records, and on several of these the turret could be seen and the scour of the sea bottom by the current around the wreck was very clear.

We were able to learn from these sonar records how the ship was disposed on the bottom. The bow is to the west, with the stern to the east and propped up on the north side by the turret which is half disclosed. Also, the scour direction to the northeast, by the current, could be seen and its length was determined. On the basis of all this work, Gordon Watts and John Newton announced on March 7, 1974, that we had definitely found the elusive *Monitor*, and John Newton, Chief Scientist of the expedition, has described it in the January, 1975, issue of the *National Geographic Magazine*.

Our entire operation in August, 1973 had been blessed with remarkably good weather. The winds were gentle to negligible. Even the current stopped for a while and reversed when we were in an eddy rolled off of the edge of the Gulf Stream as it wanders through the ocean.

Returning to the Monitor

A proposal for a second expedition was made and granted in February, 1974, by the National Geographic Society's Research Committee and the U.S. Navy, which would make available the Alcoa Seaprobe, with backup support from the U.S. Army Reserve, Duke University, M.I.T., and EG&G, Inc. April 1 was the date set for on-site action. Several people told us we would see some waves and wind. How right they were!

The expedition's goals were to refind

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A Spectrum of Strategies for Research Grants

Technology/Society
by
Kenneth E. Boulding

I suggested in the last issue that there is no adequate theory of research grants, and perhaps there can be none. This does not prevent us, however, from thinking about strategies in the minds of the decision-makers that might make for better or for worse decisions in this field.

There is no strategy for making a good decision every time; there may be strategies, however, for increasing the proportion of good decisions. This is what we have to think about.

These strategies can often be stated in the form of a continuum. Often the best way to pose the problem is: How far to go toward one end or the other of alternative strategies?

Some of these are outlined below:

How much should research grant strategy be demand-oriented or supply-oriented?

The demand-oriented grantor sits in his office and waits for applications to come in from people working in the field. He responds to the current interests of the scientific community. He naturally has to select among these interests, but he does not try to create or foster new interests. At the other extreme we have the supply-oriented grantor, who has a very strong idea as to the kind of research he wants to have done, sends out requests for proposals, gives clear indication as to what kind of research will be supported and what will not, and in general feels that he knows best.

Where we are on this continuum depends to some extent on the kind of research to be done. In strictly applied research, such as we find in commercial firms, supply-oriented activity seems quite reasonable. If it is a matter of finding out the best way of doing something quite specific, then obviously the grantor has a right to say pretty clearly and exactly what he wants to be done. On the other hand, even in commerical firms, especially the larger and more imaginative ones, there is a place for unprogrammed research in which over a loosely defined field the researcher follows his own curiosity wherever it leads him. It is only unprogrammed research that produces things that haven't been thought of, and these often turn out to be very valuable, although sometimes they do not. This is the "risk capital" problem of research which all research agencies have to face to some extent. By and large, the more fundamental the research, the less it can be programmed and the more the granting agencies, whoever they are, have to be demand-oriented.

What about "free money" versus "line budgets"?

In pure research, where what is wanted is something that nobody has thought of, the ideal arrangement is to give a competent person the funds and let him do what he likes with them. In applied research on narrow objectives, close control and line budgets are quite reasonable.

Who is to be supported?

Do we follow the principle of "to him that hath shall be given" and give grants only to people who have proved their competence by already using grants successfully? Or do we pay special attention to younger people who seem to be imaginative but who haven't proved themselves yet? Obviously, we have to be somewhere in the middle of this continuum. If we support only the established old stagers, the whole enterprise will come to an end when they die off. On the other hand, some foundations, especially, seem to have an almost pathological itch for novelty; they are prepared to support unproved workers and to put in a fair amount of risk capital in the hope of unforeseen achievements; but such foundations do not provide a continuity of support which many long-range operations require. Perhaps what we need is two granting agencies, one at each end of this continuum.

How far shall grantors rely on the judgment of peer groups in assessing research proposals, and how far on their own intuitions or on advice from outside the specialized fields?

Here again, reliance on peer groups tends to favor the well-established old hands, for really original and creative people have no peers. It is a little frightening when one reflects how much really original and creative research has been financed by pure luck, as some creative person who has no peer somehow manages to get hold of a sponsor or patron, often by sheer accident. Whether these accidents could be organized better would be a good field for research.

Large versus small projects?

We have to find some place in the middle. Some very large projects, like the space enterprise or a high-energy physics accelerator, can perhaps be justified, although one wonders whether, if we had put the space money into 10,000 small energy projects, we might have been better off now. On the whole, one feels that small projects, being a bother to granting agencies, are much harder to finance. Perhaps some research on small grants would be useful, though this study would be quite large if it were done properly!

Should grants be made to individuals or organizations, at retail or at wholesale?

At one extreme we have grants to established agencies who administer them wholesale; at the other we have prizes for individuals. Once more, I opt for a mixed strategy. A good group of scientists often produces things that an individual scientist cannot. This is the case for institutes, "think tanks," and so on. On the other hand, the lone wolf is by no means dead. "Think tanks" easily degenerate into "think-what-we-all-think tanks." There is something peculiarly corrupting about concensus and about intellectual conformity, so that we have to be a little careful about too much groupiness. One suspects that if the scientific community were really well organized, science would come to an end in 50 years, so there may be a strong case for individual prizes. The problem of the optimum degree of disorganization is always with us, and even perhaps could be researched.

Finally, the ultimate strategy question: *What organizational structure in granting agencies is likely to make better or worse decisions?*

Very little research has been done on this. There is a good deal to be said for competition in the market for grants — that is, for having a large number of granting agencies facing a large number of potential grantees. There is something of the

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Some Unsolved Puzzles of Chlorinated Hydrocarbons

Environment/Technology
by
Ian C. T. Nisbet

In my last two articles, I pointed out something of a paradox in our understanding of the environmental behavior of the persistent chlorinated hydrocarbons: DDT/DDE, aldrin/dieldrin, PCBs, and related chemicals. Although we seem to understand in general terms the pathways by which these chemicals have become global contaminants, there are some puzzling anomalies in the observational data which have prevented us from making satisfactory quantitative transport models. This article will discuss some of these anomalies and will show that the critical processes limiting the transport of these chemicals — in particular the rates of transfer between solid, liquid, and gaseous phases — are still very poorly understood.

Losses from Soils

For most soil insecticides, evaporation is now known to be a major route of loss. The most volatile chemicals (e.g., aldrin and chlordane) disappear most rapidly from soils, and their rates of volatilization can be measured directly by sampling vapors above treated fields. However, their disappearance does not usually follow a first-order relation: A rapid loss in the first days or weeks after application is followed typically by a much slower loss in subsequent months or years. Evidently part of the applied material becomes tightly bound to the soil and is released only slowly.

Extensive monitoring of U.S. soils has shown that DDT and DDE are still present in substantial quantities in areas where DDT has been used in the past 10 to 20 years. Allowing for the fact that only a part of the sprayed chemicals ever reached the soil, at least one-third (and probably two-thirds or more) of the DDT originally applied can still be accounted for in the treated areas. DDT is one of the least volatile insecticides and its release from soil is evidently slower than was once thought.

Although DDT is found very widely in soils that have never been treated, the amounts found are quite modest in relation to the quantities that fall each year in dust and rain. The simplest explanation for this anomaly is that the material falling-out is concentrated on the soil surface and is readily re-evaporated. However, re-evaporation has not been verified by direct observation because of the small quantities involved.

Although most pesticides volatilize much more rapidly from moist soils than from dry soils, the precise mechanisms are not fully understood. The phenomenon of "co-distillation," responsible for rapid losses of pesticides from aqueous solutions, is probably not important in soils because flooding actually retards losses. In one study with dieldrin, for example, losses from test plots during a five-month period amounted to 7 per cent from dry soil, 18 per cent from moist soil, and only 2 per cent from flooded soil. The repeated evaporation of rainwater within moist soils and the consequent upward movement of water vapor can lead to rapid upward displacement of pesticide vapors with porous soils. However, this mechanism appears to be important only for the more volatile chemicals, and its efficiency is limited by the tendency of these chemicals to be adsorbed onto soil particles. A third mechanism, "wick distillation" — the phenomenon utilized in wick-type air fresheners, in which a relatively non-volatile material is transported through a porous medium in solution in a more volatile solvent, to evaporate with it at the upper surface — is probably important for the soil pesticides that are most soluble in water, such as dieldrin. However, here also the efficiency of the process is limited by the tendency of the pesticides to be adsorbed onto surfaces. Lacking critical studies, we simply do not know which of these mechanisms controls the rate of volatilization.

Although microbial degradation of pesticides has been studied extensively in the laboratory, there is little direct evidence that it is a primary route of loss from soils. The major metabolites — DDE from DDT, dieldrin from aldrin, heptachlor epoxide from heptachlor — are longer-lived than the parent compounds and their formation does not represent detoxification. The relatively small quantities of DDE found in treated soils suggest that degradation is not a major route of loss of DDT from soils (DDE is slightly more volatile than DDT, but not sufficiently so to account for the low DDE/DDT ratios usually observed). In one of the few detailed studies carried out in actual field conditions, a test plot in Germany was treated with labelled aldrin; subsequently both dieldrin and other breakdown products were recovered from the soil and crops, and volatilization appeared to be a relatively minor route of loss. However, in the American Midwest, concentrations of aldrin and dieldrin measured in air in recent years have been sufficiently high to account for most of the aldrin used there in the same period. Differences in soil type and in ambient temperatures may account for this discrepancy.

Air Transport and Fall-Out

The key factors controlling atmospheric transport and deposition of pesticides appear to be their partitioning between the vapor phase, airborne particulates, and raindrops. Studies in Britain, for example, have suggested that lindane and dieldrin are present in air primarily in the vapor phase. Lindane, being relatively soluble in water, is fairly efficiently washed out in rain, but dieldrin is less soluble and is thought to have a long residence time in the atmosphere.

In contrast, several studies have indicated that DDT and DDE are strongly adsorbed onto airborne particulates and travel long distances on them. In consequence both sedimentation (dry fall-out) and removal in precipitation (wash-out) are important routes of deposition. One British study suggested that the residence time of DDT in the atmosphere should be as long as six months. However, the direct evidence for long-range transport of DDT/DDE is conflicting. Measurements of airborne residues at Barbados (on airborne dust), at Bermuda (in air) and in Iceland (on dustfall) have indicated concentrations lower than those over the continents, suggesting residence times of only a few days. However, one analysis of An-

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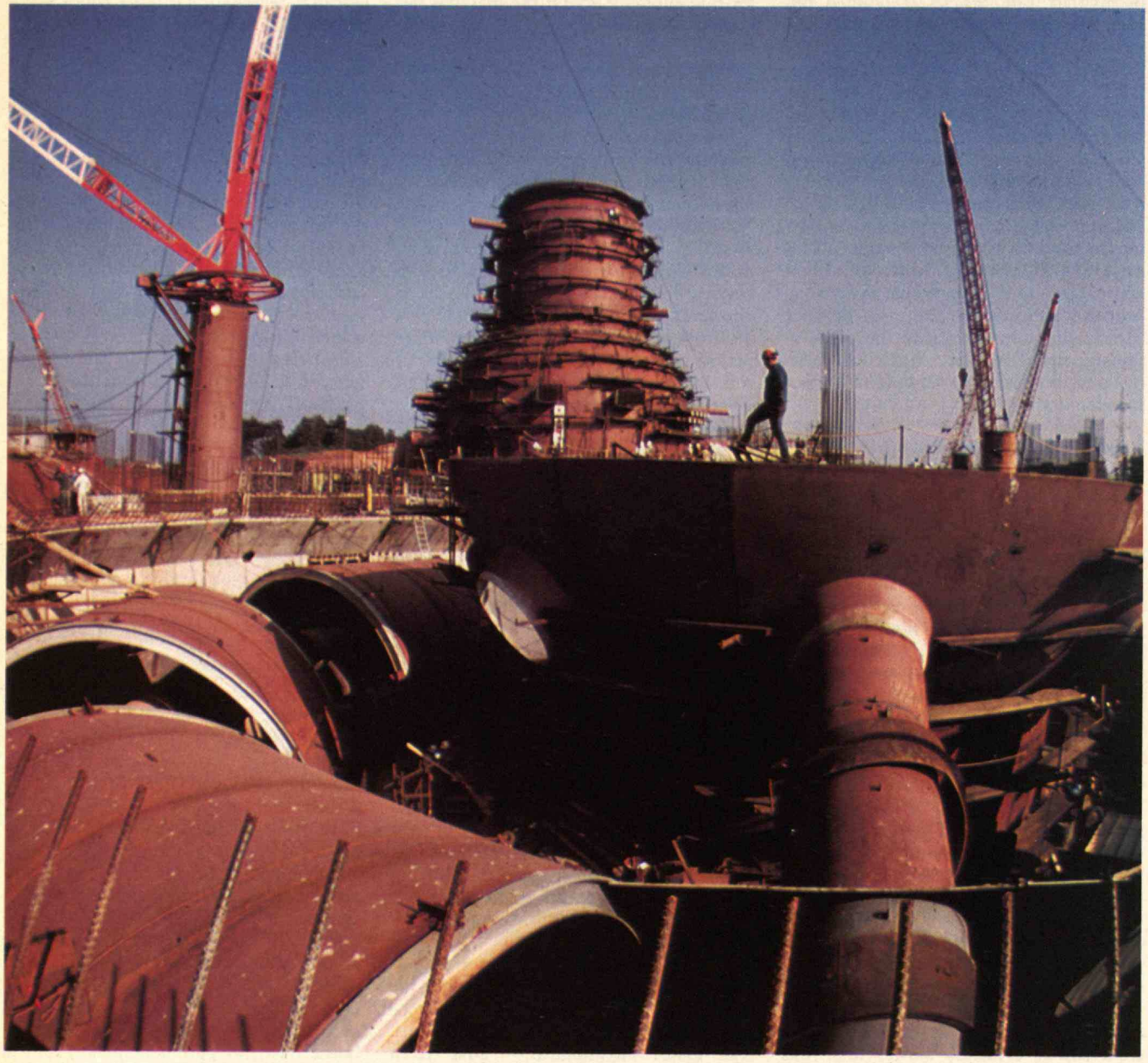
The political controversy over nuclear power has contributed to enormous increases in capital costs of light water reactors; perhaps enough to offset cost advantages over coal.



Construction of the Tennessee Valley Authority's Brown's Ferry nuclear plant complex, now in operation, was delayed significantly by new federal regulations, as were many plants now coming on line. The three-unit plant, with a total generating capacity of 3½ million kilowatts, is the world's largest nuclear power facility. (Photo courtesy Atomic Industrial Forum)

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The Economics of Nuclear Power

It has been less than 20 years since a water-moderated and -cooled reactor began to produce 60 megawatts (Mw.) of electricity for the Duquesne Power and Light Co. at Shippingport near Pittsburgh, Pa. In that brief period the technology demonstrated by the Shippingport reactor appears to have achieved a stunning commercial success. A consensus has developed among affected businessmen and public officials in virtually all industrialized countries that nuclear fission is the only practical alternative to fossil fuels for the next 30 to 50 years. In many areas, light water reactors (LWRs) are already believed to be the most economically attractive technology for generating base-load electricity and are expected to remain so for the foreseeable future. These beliefs have now led to the commitment of the equivalent of many billions of dollars to construct several hundred LWRs in the United States, western Europe, and Japan. In France, the government-owned power monopoly, Electricité de France, has contracted with the French subsidiary of Westinghouse to build 18 LWRs, each capable of generating 900 Mw. of electricity. In New England, the largest investor-owned power company, Northeast Utilities, has committed its entire baseload capital expansion program through 1985 to nuclear power. This decision alone represents an estimated $3 billion.

On the basis of this record the proponents of nuclear power might justifiably take pride in having brought about one of the 20th century's most important technological innovations in, as Glenn Seaborg has noted, "just the nick of time." Nonetheless, the controversy which has surrounded, if not overrun, the technology since World War II shows no signs of abating. Serious doubts about the value of nuclear power persist among influential people in all of the countries where reactors are being built (with the possible exception of France).

In the United States an area of growing concern to both supporters and critics of nuclear power is the cost of the LWRs now on order or under construction. Over the past ten years impressive evidence has accumulated to justify early predictions that the fuel cycle (or variable) costs of nuclear power would be low. This prediction has been remarkably accurate, absolutely as well as relatively. In 1965 LWR fuel cycle costs were estimated at 17-22 cents/million B.t.u. Today they remain at about 24 cents/million B.t.u. In the same period, fossil fuel costs have jumped staggeringly from 24 cents/million B.t.u. to more than $2.00 for oil and $1.00 or more for coal. These circumstances account for the fact that in many areas of the U.S., notably New England and the Middle Atlantic states, light water reactors are now the most economically attractive technology for generating base-load electricity.

The capital cost situation is far less reassuring. It has been evident from the beginning of the commercial nuclear era that the key to nuclear economic success was to prevent a virtually certain fuel cost advantage from being wiped out by high construction costs. The fact is, however, that even though more than 200 LWRs are on order, under construction, or in operation in the U.S., the long-term construction costs of nuclear power are still highly uncertain. All that we know with confidence is that large — more than 450 megawatts electric (MWe.) — LWRs are more expensive to build on a constant-dollar-per-unit output basis than it was believed they would turn out to be when the first such machines were sold about nine years ago. (In this report, "capital costs" will always refer to total costs, including interest, during construction.)

In 1965 it was supposed that large LWRs could be built for approximately $130 per Kilowatt (Kw.) Boston Edison's Pilgrim Station, a 660-MWe. boiling water reactor which went on line in 1972, cost more than $300/Kw. Somewhat larger (1,000 MWe.) plants now on order to go into operation in the early 1980s are estimated to cost about $700/Kw. Does this mean that LWRs have doubled in cost between 1965 and 1974 and will double again in less than ten years? Not necessarily. A cost comparison is obviously complicated by the fact that reactors are built over a period of several years. The cost record of any given plant is therefore a heterogeneous aggregate of different kinds of dollars. Consider, for example, a hypothetical plant ordered in 1967 and entering operation in 1974. The nuclear heart of the unit, the so-called "nuclear steam supply system" (NSSS) — reactor core, control rods, pressure vessel, etc. — may have been purchased and paid for in 1968 or 1969 dollars and the turbine generator in 1971 or 1972 dollars. The total capital cost of the plant as reported by the utility to the Federal Power Commission is an aggregate of these and other items, each expressed in (varying) current dollars.

A second problem in trying to understand how the real cost of LWRs has changed over time is that plants ordered in different years are not technically equivalent. Important design changes have been made in all LWRs to take

This article is a condensed version of "Trends in Light Water Reactor Costs in the United States: Costs and Consequences," a report from M.I.T.'s Center for Policy Alternatives.

advantage of economies of scale and to meet changing nuclear safety and environmental protection standards.

To develop a meaningful cost comparison of LWRs we want to know two things: What has happened to the capital cost of LWRs in real terms (constant dollars) in the decade since the first commercial orders were placed; and what is likely to happen in the coming decade?

In the U.S. there are approximately 60 LWRs which are either in operation or at a stage of construction such that they will be operating by the end of 1975. We have assembled the capital cost records of 48 of these reactors. We will use this data to attempt to answer the question about what has happened. We have also assembled cost estimates for an additional 25 reactors in initial or mid-stages of construction. We will use this less firm data to try to develop some sense of how the situation is changing. On this basis we will then try to sort out the causes of the trends we observe. A matter of special interest is the relative magnitude of the cost increases due to escalation of equipment and field construction costs as distinct from increases caused directly or indirectly by licensing or regulatory delays. Finally we will speculate upon the consequences of the situation revealed by this analysis for both the reactor manufacturing and construction industries and the electric utility industry.

A Meager U.S. Reactor Construction Experience, 1964-1975

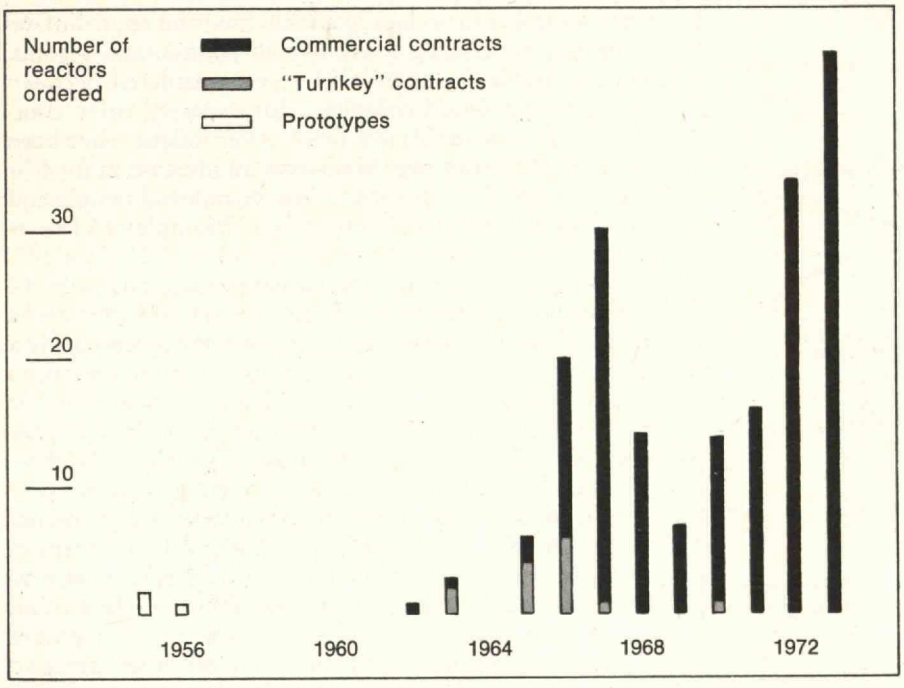
The development of the commercial power reactor industry in the U.S. can be roughly divided into three periods. First there was the precommercial experimental and prototype phase of the late 1950s and early 1960s. This was the period dominated by the A.E.C's still controversial "Cooperative Power Reactor Demonstration Program." The A.E.C. provided construction and operating subsidies for experimental reactors of various designs which were, upon completion, to be operated as part of the commercial generating systems. This program eventually involved five joint ventures between the A.E.C. and investor-owned utilities and four with cooperative and government-owned systems.

The initial phase of reactor development ended in the fall of 1963 when the Jersey Central Power Co. announced an agreement with the General Electric Co. according to which G.E. was to build and turn over to the utility at a fixed price a 640 MWe. boiling water reactor. The terms of this "turnkey" contract between Jersey Central and G.E. were such that the prospective "Oyster Creek" plant would generate base-load power at a lower cost to the utility than could an equivalent coal- or oil-fired plant. The first "turnkey" contract for a commercial scale LWR was quickly followed by several others. These arrangements were widely regarded as both proof of the commercial promise of nuclear energy and as vindication of the A.E.C.'s bitterly controversial promotional activities.

In fact, things were not quite so simple. It is now widely agreed that the contemporary estimates of the cost of electricity generated by the early "turnkey" plants were very optimistic. The reactor manufacturers, Westinghouse and G.E., more or less consciously risked substantial financial losses to secure market shares in what they viewed as the power generating technology of the future. Although the losses they ultimately incurred on the turnkey contracts almost certainly exceeded their expectations, the strategy was probably a success. Equipment costs did decrease as both manufacturers and utilities "learned by doing." But perhaps most important, the early turnkey reactors had a powerful demonstration effect upon the utility industry here and abroad, as their mere presence appeared to confirm the realism and imminence of civilian nuclear power.

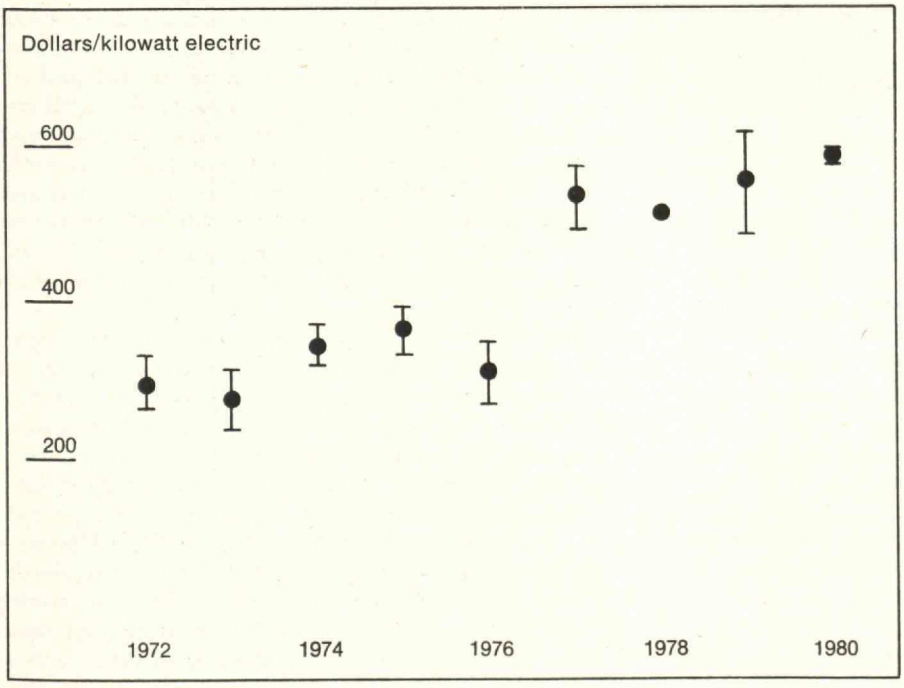
The third phase of reactor commercialization began in 1965 when utilities placed the first orders for reactors without firm "turnkey" price guarantees by the manufacturers. This date is important: It means that in the U.S. there has been less than ten years' experience in constructing large LWRs on a completely commercial basis. Even this greatly overstates the case because of the time it has taken to build the plants which were ordered in that period. In 1965-66 it was expected that about six years would be needed to build the reactors then on order. In fact, most of the early non-turnkey plants are still not complete. By December, 1973, only six of 30 reactors ordered in 1967 had entered operation. Of all 27 plants in operation by 1973, only 14 were non-turnkey (see the top figure on the opposite page).

Hence the firm information available to understand the current economic status of nuclear power is quite meager. Two sources of data are available to us: a fairly reliable but small set of cost records on completed plants; and a far larger but considerably less reliable set of cost estimates for plants on order or under construction. The distinction, though obvious, is nonetheless important, for surprisingly few published analyses of the economics of nuclear power systematically distinguish fact from expectation.

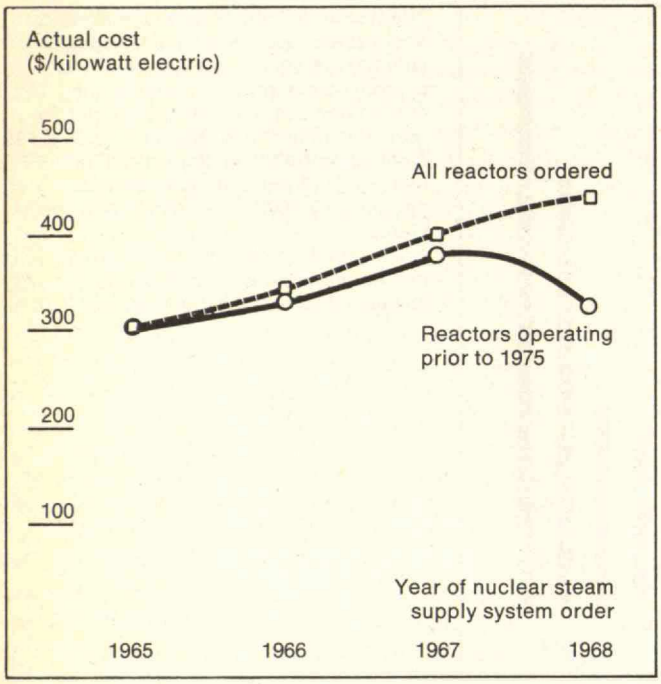


The history of light water reactor orders: The three phases of the nuclear power industry are shown graphically — the precommercial prototype phase, the guaranteed-cost turnkey phase, and the regular commercial phase. Of a total of 189 plants ordered by January, 1974, only 27 (less than 15 per cent) had entered operation by 1973, of which 13 were turnkey plants.

Thus, only 14 commercial-contract plants had entered operation by the end of 1973, making commercial experience still limited.



The average unit cost of non-turnkey commercial plants per year of operation shows an impressive dispersion and increase in nuclear plant costs. (± standard error indicated)



The earlier reactor operation, the lower the cost. This graph illustrates that measuring the average cost of reactors does not give a true picture of reactor cost trends, for, of reactors ordered between 1965 and 1968 (top line), the cheapest are those expected to go into operation by the end of 1975 (bottom line).

Allowing for Inflation

The first problem is to control for the effects of monetary inflation. To do so we have deflated the available capital cost information by using regional indices of inflation and assuming:

— Total expenditures for a given plant are spread over the construction period as follows: 15 per cent are incurred at the start of construction, 70 per cent by mid-construction, 100 per cent by the end of construction.

— Costs incurred beyond 1974 are deflated by a flat 8 per cent per year. Although this is lower than current estimates of future inflation rates in the U.S., it is very close to the escalation rule used in 1973 when utilities and constructors made the cost estimates used in this analysis.

Capital Costs: Increase and Misestimation

We have summarized the capital cost situation of non-turnkey LWRs (see the bottom chart on p. 17), first from the reasonably firm data available (i.e., the record of 36 completed or essentially completed plants); and second, from a broader sample of 51 reactors ordered between 1965 and 1970 and completed (or expected to be completed) between 1971 and 1981. After inflation has been taken into account, we do observe an increase in nuclear plant cost of $27/Kw. per year on the reduced sample and an increase of $23/Kw. on the broader sample of 51 reactors.

Several points should be emphasized. First, only 14 non-turnkey plants larger than 450 MWe. had entered operation by December, 1973. Second, there is typically a very large range in the costs of plants entering operation in any one year. For example, of the six plants in our sample which entered operation in 1973, the least expensive cost $213/Kw. and the most expensive $418/Kw. (1973 dollars). Hence, the trend of average costs per year of operation only partially illuminates reactor construction experience in the U.S. Third, the 14 non-turnkey plants larger than 450 MWe. which had entered operation by December, 1973, represent only a fraction of all plants ordered between 1965 and 1968. Since they were the units which were built most rapidly, they are also likely to be, on the average, the least costly. A comparison of the cost trends for all the reactors ordered between 1965 and 1968 with those ordered during the same period, but expected to be in operation by the end of 1975, illustrates this situation (see the figure above). If we look only at reactors ordered in 1968 and built or nearly built, costs appear to be going down. However, if we look at all reactors ordered between 1965 and 1970, costs are rising monotonically. Moreover, the rate of increase is more steep for plants ordered subsequent to 1970, of which virtually none is today complete or even in final stages of construction.

In the chart on the opposite page, we attempt to compare this increasing cost situation with the costs anticipated at the time reactors were ordered. From the similar shape of the two curves, we can conclude that the trend of reactor costs was more or less correctly anticipated, but the absolute magnitude seems to have been badly misestimated. For example, in 1968 the reactors were expected to cost only $180 per kilowatt electric (KWe.). The actual average cost of reactors ordered that year is about $430/Kw. This suggests a misestimation of some $250/Kw. in 1973 dollars; moreover, it is evident that this difference has not been narrowing with time.

A recent study of nuclear power economics by the World Bank observes: ". . . Current cost estimates are

thus likely to be more reliable than was the case in the past, a view supported by contracts presently being executed." This is simply not true. We just have little firm idea of what the actual cost in deflated dollars of reactors ordered subsequent to 1969 will turn out to be.

The U.S. Federal Energy Administration's Project Independence "Blueprint" estimates the capital cost of an LWR ordered in 1974 to enter service in 1982-83 at $455/Kw. (1974 dollars). All of the evidence available to us strongly suggests that this estimate will prove to be too low — almost certainly by 25 per cent, probably by 50 per cent, and quite conceivably by 100 per cent (in constant dollars).

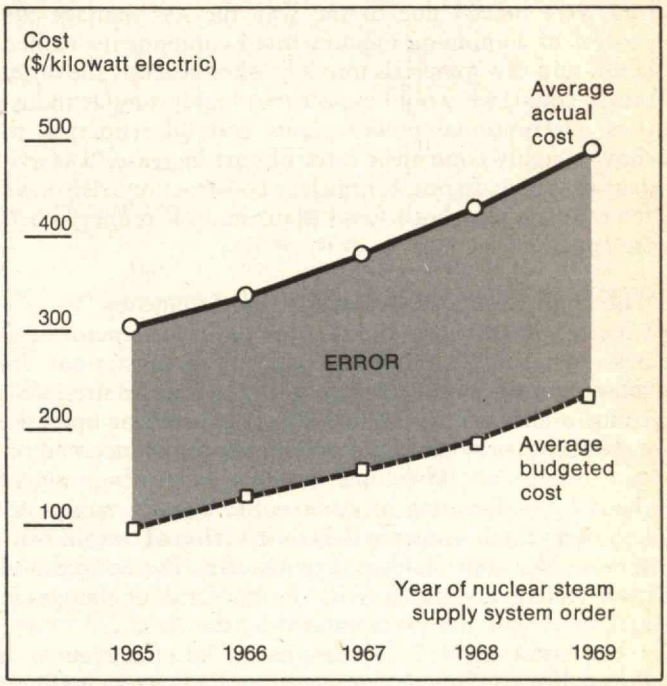
Causes of LWR Cost Increases: Conflicting Views

There is no scarcity of confident explanations for the failure of LWR capital costs to stabilize in the past few years. Utilities and the A.E.C. hold views which are perfectly contradictory (see p. 22). The generally accepted belief of the utility industry places the blame chiefly upon the effects of the A.E.C.-mandated environmental reviews, quality assurance programs, and safety related design changes. The A.E.C. on the other hand, points to poor labor productivity, equipment manufacturer performance failure and other construction problems as the principal villains.

Another cause of concern to some has been the structure of the reactor manufacturing industry. It is an industry whose most salient characteristic is a very high degree of concentration. It is also, however, widely recognized that the costs of the major manufactured actual components of LWRs have been decreasing, both absolutely (in constant dollars) and as a fraction of the total plant capital costs. There does appear to have been modest learning in the manufacture of the NSSS not withstanding significant design changes and scale modifications. The turbine generator has benefited from somewhat larger savings. Apparently we must look beyond the manufactured components — the so-called "balance of plant" — to identify the reasons that plant costs have exceeded expectations.

Central Role of the Architect-Engineer

The key position of the architect-engineer (AE) bears emphasis. It is the AE, strategically situated between the seller and buyer of the reactor, who combines three chief inputs — manufactured components, skilled engineering, and construction labor and raw materials — into a complete reactor. It is precisely that fraction of the total cost



Gross misestimation of reactor costs has troubled the nuclear industry. The bottom line represents estimated costs of a reactor ordered in a given year, and the top line the actual costs ordered or expected (1973 dollars).

under the control of the AE that has been increasing. Let us look more closely at manpower and materials. First, the relative share of labor in the construction cost of reactors has sharply increased over the last few years, as is widely recognized. In addition to the direct effect of wage increases, the most common explanation for this situation has been a shortage of qualified manpower and a decline in labor productivity. A practical effect of this has been a steady increase in the number of man-hours per Kw. to build a reactor. Reactors going into operation in the 1970s required about 3.5 man-hours per Kw. to build, while those slated for the 1980s will require 8.5, according to an A.E.C. study.

But some would argue that what has happened with labor costs in the nuclear industry is not unique to this business. The same sort of increases have affected fossil-fueled generating plants and oil refineries — indeed, all large construction projects. If the increasing costs of reac-

tors were indeed due to the way the AEs manage the process of combining manufactured components, skilled labor, and raw materials into a finished reactor, the other things equal, we would expect two highly similar industries, conventional power plants and oil refineries, to show roughly equivalent rates of cost increase. It is evident that they do not, for nuclear construction costs have far outdistanced both fossil plant and oil refinery costs (see p. 21).

The High Costs of Controversy and Stringency

Clearly something special is going on in the reactor business. What this is cannot be particularly mysterious. Intense concern about the safety of reactors persists. This concern has had two related effects which bear upon the capital cost problem. First, intervention of concerned organizations and individuals at the public hearing stage of the A.E.C.'s licensing procedures has directly caused delays of a year or longer in the construction of certain reactors — Vermont Yankee, San Onofre. The second and more general consequence has been a series of changes in reactor design criteria mandated by the A.E.C.

For instance, in 1966 the question of effectiveness of the nuclear core's emergency core cooling system was first raised. The major effect of this was a tightening in 1972 of the criteria governing this system, resulting in a certain amount of incremental cost.

Similarly, the promulgation of radiation protection levels "as low as practicable" in 1971 contributed $3-5 million in incremental construction costs.

Another delaying and costly development was the so-called Calvert Cliffs Decision which established that nuclear plants, like all other projects, had to file thorough environmental impact statements on their projects.

The quantities of materials used in reactor construction illustrate the effects of stricter regulation. In the earlier years of reactor construction, amounts of concrete and steel per Kw. decreased steadily, reflecting economies of scale. Between 1965 and 1970 this trend reversed, in spite of continuing increases in the total size of the reactors being built, and, thus, continuing increases in economies of scale. This is obviously a consequence of more stringent nuclear safety and environmental protection design criteria.

A more important factor affecting costs is the steady increase in reactor construction time during the last eight years. For reactors ordered in 1965 average construction time was about 85 months, rising to about 115 months for 1969-ordered reactors. What's more, comparisons of original estimates of construction time with most recent estimates show a gap similar in consistency to the one for cost estimates. As with costs, misestimation appears to have been increasing. These unanticipated delays could account for the gap between actual and estimated cost in three ways: First, delays imply additional unanticipated inflationary effects. To the degree that costs are actually incurred later than originally anticipated, the initial escalated dollar estimate of the magnitude of such costs will be in error. Second, delays imply additional interest on the funds borrowed by utilities to finance reactor construction. Finally, direct construction costs are also affected by delays.

A Statistical Analysis

This rapid survey of the possible causes of reactor cost increases underlines the complexity of the problem. There is no simple qualitative explanation. Clearly, the outcome we have observed is the result of a complex interaction among several partially offsetting and partially reinforcing factors (see p. 22).

In order to obtain a more precise quantitative sense of this situation, we have undertaken a modest statistical analysis of the simultaneous effects of several different types of factors, each of which we know to have influenced LWR capital costs in some fashion. These factors can be grouped into four categories:

— Time-related factors: the year of reactor order, year of operation, etc.;

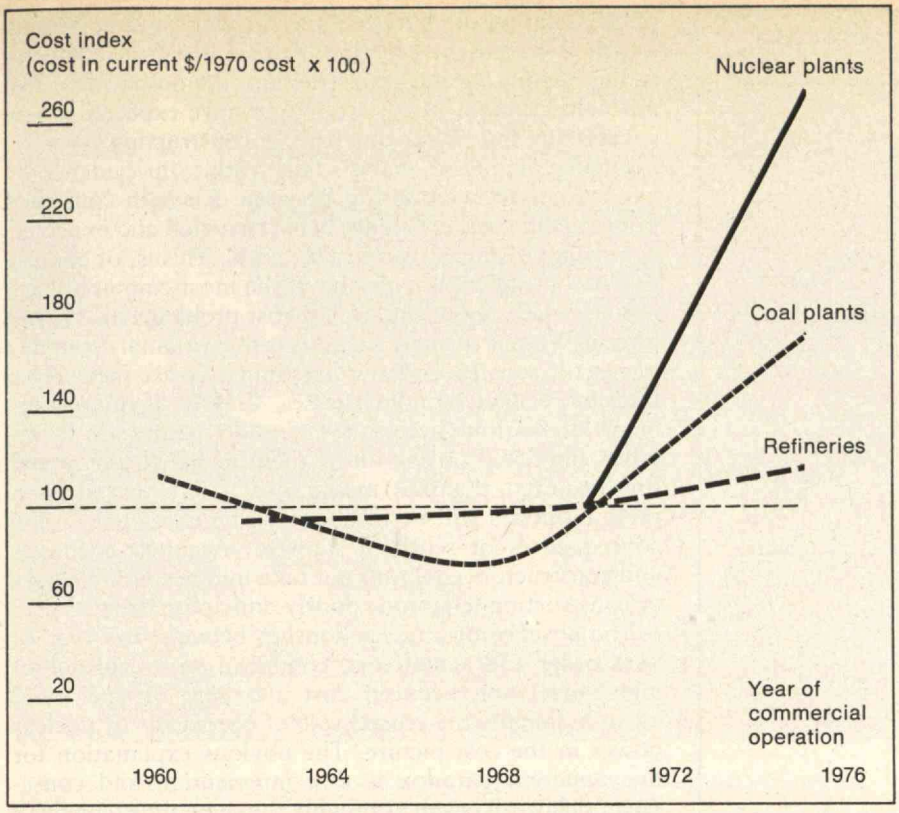
— The characteristics of the licensing and construction period: total length of time from NSSS award to reactor operation, length of licensing procedure, length of construction on site;

— The physical characteristics of the reactor, such as size in MWe.;

— Geographical and site-related factors for the area in which a reactor was built (Northeast, other areas), for the number of units of the same size, (one unit, several units), and for the cooling system used.

Higher Costs — Licensing Period and Location

This analysis underlines the strong correlation between plant costs and total project length. But, while there is apparently no relationship between the on-site construction length and cost, the length of the licensing period is rather strongly correlated with costs. Moreover, nuclear plant costs appear to be significantly correlated with the ratio between licensing period and total length of the project. This means that for a given project length, the



The cost trend for nuclear plant construction has outdistanced coal plant costs and oil refinery costs, indicating that labor and other construction costs do not tell the whole story of nuclear plant cost increases.

longer the licensing period, the higher the total cost.

As we already know, the year of operation is correlated with cost. A weak relationship between reactor size and cost appears to confirm that anticipated economies of scale have been partially offset by other influences. Among site-related variables the geographic location of the plant seems to have the strongest association with costs.

Can Coal be Competitive with Nuclear?

The capital costs of large light water reactors show no signs of stabilizing and, indeed, are apparently still climbing at alarming rates. The implications are very important: Will the fuel-cycle cost advantage of nuclear power over coal possibly be offset by the capital cost differential between the two technologies?

A statistical analysis of the cost of 102 coal-fueled power plants, built between 1960 and 1975 shows that coal plant costs have also increased — at an average rate of $13 per Kw. per year over the period 1969 to 1975. This figure, compared with a $31/Kw. / year increase for nuclear plants, suggests that the capital cost differential between the two technologies is increasing at $19/Kw./year. The corollary with respect to fuel costs, of course, is that the breakeven price of coal is also increasing. The breakeven price is simply the coal price which equates the total cost of power produced by the two technologies for assumed values of the capital and operating costs of both methods plus nuclear fuel cost. If things continue as they have in the recent past, coal delivered to a plant at 58 cents/million B.t.u. could be competitive with LWRs in 1975. Coal delivered at 74 cents - 92 cents/million B.t.u., depending on the assumptions made, could be competitive with nuclear power by 1980.

We should stress the empirical uncertainty of several critical matters. All estimates of future (indeed, even of present) capital costs of nuclear power are really little more than educated guesses. Second, the future cost of coal is far from certain, and very much depends upon, among other things, the politics of air pollution control. According to present estimates, anti-pollution devices needed to satisfy 1975 air pollution standards will add at least $50/Kw., and perhaps more than $100/Kw., to the cost of coal-fired plants. These possible extra costs are not taken into account in our analysis.

Finally, the breakeven cost calculation is sensitive to variations in the parameters whose values we have assumed: The fixed charge rate for capital amortization, the coal heat rate, and the capacity factor (see p. 24).

Obviously, these very rough analyses cannot support a definitive comparison of the present and future comparative economics of nuclear and coal base-load power. Some qualitative observations do, however, appear to be in order: The present trends in reactor capital costs are significantly narrowing the economic gap between the two technologies. It would be a great mistake to assume that the present economic advantage held by LWRs is permanent. The best available evidence points to the need for careful and continuing attention to the comparative base-load economics of nuclear and coal-fired plants.

Interpreting Cost Increases: Social Acceptability Important

We believe the strength of "licensing" in the statistical explanation of nuclear plant cost changes is the most interesting result of that analysis. It may also turn out to be the most controversial. A few points are relatively clear. As we've said, increases in the licensing period obviously entail certain extra direct costs such as environmental assessments and reports, legal fees and other expenses incidental to public hearings and litigation. But these direct licensing costs represent only a very small part of the ef-

A Utility's View

- Changes in project scope
- Environmental studies
- Safety questions
- A.E.C. question/answer requirements
- Additional radiation shielding
- Reactor protection system changes
- Radiation monitoring system changes
- Engineered safeguards
- Fuel cask decontamination and transportation
- Mechanical draft cooling towers
- Additional off-gas treatment
- Sharp rise in labor, materials and interest
- Delay of more than three years

The A.E.C.'s View

- Poor productivity of labor
- Late delivery of major equipment
- Change in regulatory requirements
- Equipment component failure
- Construction labor strikes
- Shortage of construction labor
- Legal challenges
- Factory labor strikes
- Rescheduling of associated facilities
- Weather

Electric utilities and the Atomic Energy Commission hold perfectly contradictory views of nuclear reactor cost increases, each essentially blaming the other. The utility view represented here is that of Northeast Utilities, and the A.E.C. view is taken from a report in *Chemical and Engineering News*, November 26, 1973.

fect of the regulatory process upon reactor costs. For, in general, increases in the licensing time are the practical manifestation of a complex interaction among nuclear energy opponents, the utility applicant, and the A.E.C. regulatory machinery. This interaction results, among other things, in reactor design changes and new safety criteria. For a given reactor, the length of the licensing period is probably a good indirect index of the cost effects of such difficulties.

One example is the effect of some A.E.C. regulatory changes on the cost of the Northeastern Utility "Millstone #2" unit. In this instance, the A.E.C.'s regulatory apparatus responded to intervenors by ordering the retrofit of additional protection against pipe rusting outside containment. The cost of this requirement has been estimated to be about $5 million.

The importance of licensing in explaining cost increases is confirmed by the relationship between the total cost and the ratio of licensing period to total project length; as we have already noted, for a given total project length, the longer the licensing time, the higher the cost. This statistical result can be interpreted in the following way: A utility which is spending more time than expected on licensing doubtless tries to compensate for such delays by speeding construction as best it can. This certainly entails additional unforeseen costs, more intensive use of certain manpower, and drastic changes in planning, among other things.

This interpretation may also shed light on the absence of any relationship between nuclear plant unit costs and length of on-site construction: Apparently some compensating factors during construction period modify the normal variations in cost we might have expected when considering the effects of length of construction.

Finally, statistical analysis fails to turn up evidence of any systematic relationship between delays in construction schedule (the difference between actual and expected construction length) and reactor costs. This is, of course, in flat contradiction with one of the most commonly accepted beliefs about the capital cost problems of nuclear power. What it strongly suggests is that original estimates of reactor construction and licensing time are themselves little more than random guesses. Clearly, if initial estimates of the time necessary to build reactors are themselves unrelated (as we know them to be) to the actual time required, then any measure of "delay" based upon these estimates will necessarily also be unrelated to any consequences of schedule slippage. Architect-engineers and constructors either do not take into account changes in construction length, or poorly anticipate them.

The absence of any relationship between the year of NSSS order and actual cost, combined with evidence of high correlation between cost and year of operation, again highlights the crucial role of opponents of nuclear power in the cost picture. The obvious explanation for this apparent paradox is that intervention and consequent delays all began at roughly the same time (chiefly in the early 1970s), and in general affected reactors regardless of the year they had been ordered.

Let us now try to view all of these circumstances from a somewhat broader perspective.

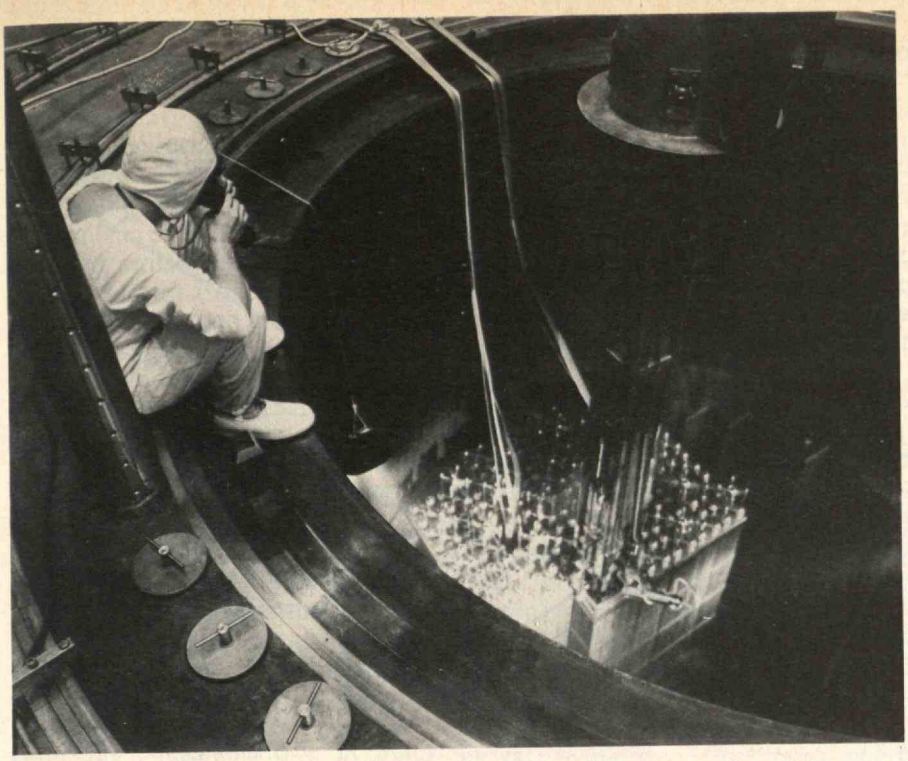
Energy Pricing a Question of Political Power

The price of usable energy from oil, coal, or uranium now has little to do with the marginal production cost of any of these resources. Nor does it have much to do with the marginal cost of manufacturing and assembling the equipment necessary to convert the energy in these resources into consumable form. Instead, the price of energy from alternative technologies is the result of a complicated process of assigning relative values to a variety of energy-producing resources and technologies by those who either control or require these resources and technologies. This process is both intensely and inherently political. The last point bears special attention. Most of the world's governments have now accepted the need to develop energy policies. The purpose of such policies is commonly formulated in terms of a requirement to bring supply and demand into long-term balance, subject to various technical, economic, and political constraints. Often the "political constraints" are assumed to be somehow the least real. Hence, the belief, now widespread among affected businessmen and public officials, that political opposition to nuclear power will vanish as soon as the public has realized that this technology is the best available way for society to meet its energy needs.

But there is a strong (and perhaps growing) disagreement within American society on whether nuclear power does indeed represent a valuable way to generate electricity, in the face of what is perceived to be social costs.

Among the opponents of nuclear technology, two different attitudes are apparent:

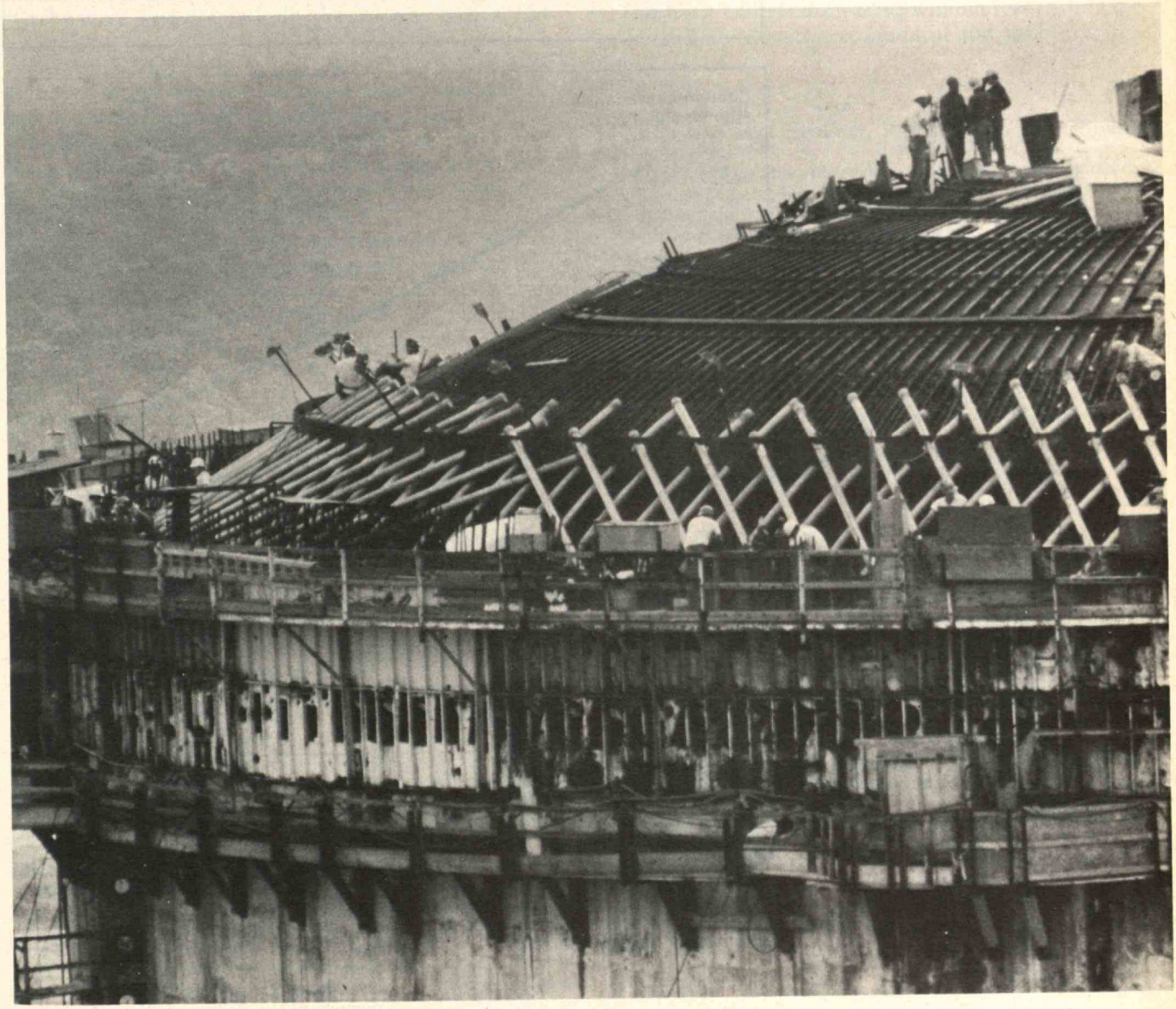
— Some consider that today's relatively cheap cost of electricity from reactors is not an acceptable indicator of the "net social value" of the technology. This "net social

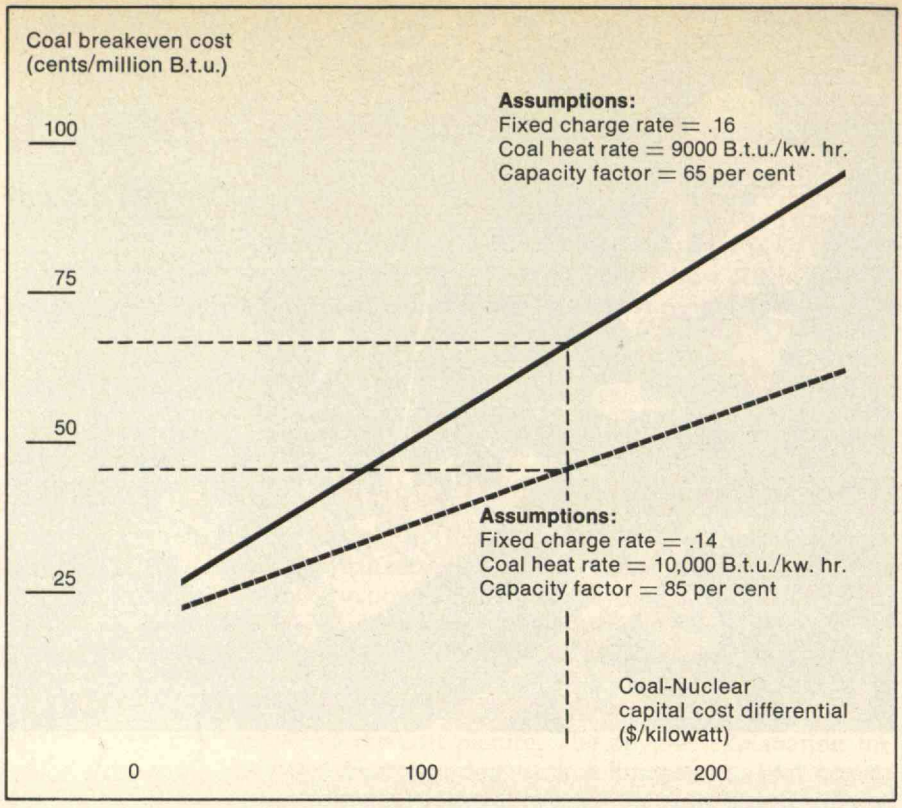


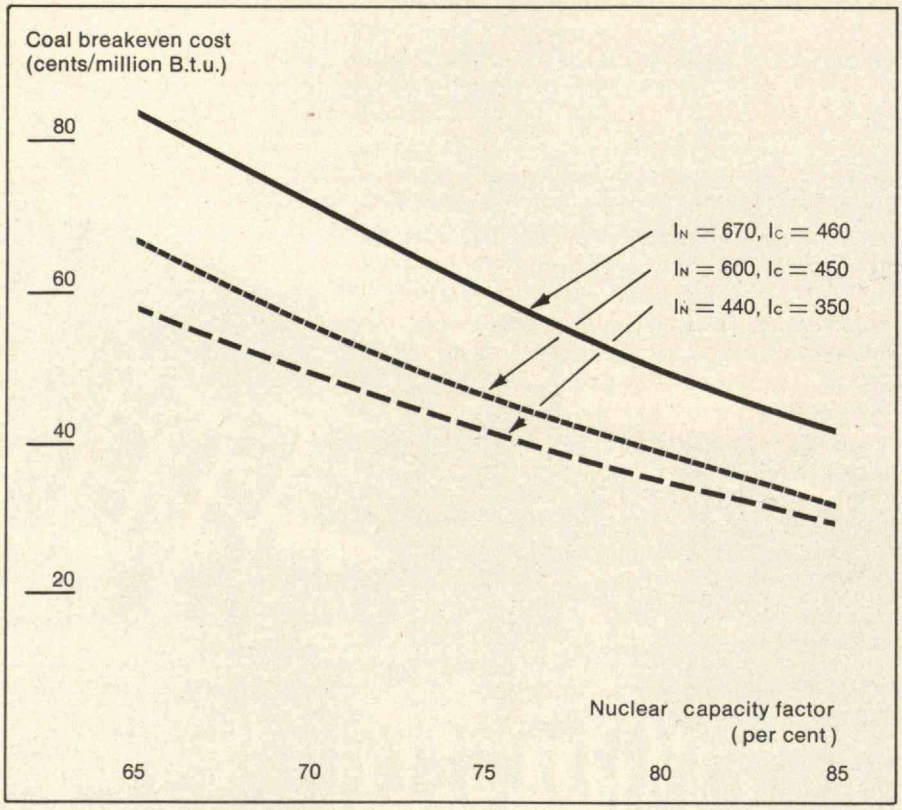
Left: Nuclear fuel is loaded into the number one unit of the Calvert Cliffs Nuclear Power Plant in Maryland. A lawsuit brought by groups opposing the plant lead to the now-famous "Calvert Cliffs Decision" which held that nuclear power plants were required to submit extensive environmental impact statements. The ruling contributed significantly to nuclear plant construction cost increases. (Photo courtesy Combustion Engineering, Inc.)

Below: The enormous number of hand-welds done on a nuclear plant's reactor containment vessel must be carefully X-rayed. Such precision means a nuclear plant is very labor-intensive, making the recent sharp increase in the proportion of labor costs involved in power plant construction damaging to power plant economics.

The plant shown is Florida Power Corporation's Crystal River Three power plant, due to be operable last year, but now indefinitely postponed. Recent surveys have shown that 28 nuclear power plants already under construction have been delayed or postponed because of funding difficulties. (Photo courtesy Atomic Industrial Forum)







Coal break-even cost is sensitive to the fixed-charge rate for capital amortization, the coal heat rate, and the capacity factor. The top chart shows that, for a given capital cost differential between coal and nuclear plants ($150/Kw.), the break-even cost varies between 48 cents/m.B.t.u. and 69 cents/m.B.t.u., depending on the value assumed for these three factors.

The nuclear capacity factor also affects coal break-even cost, as the bottom chart shows. For a capital cost differential of $150/Kw., a shift in the nuclear capacity factor from 80 per cent (originally expected for nuclear plants) to 65 per cent (a high figure as compared to average reactor operation records) causes the breakeven cost of coal to move from 38 cents/m.B.t.u. to 66 cents/m.B.t.u. (I_N and I_C are investment costs for nuclear and coal, respectively, in dollars per Kw.)

value" is today *overstated,* they contend, as some risks and social costs associated with nuclear power are not yet properly internalized in reactor prices. Therefore, these opponents have attempted to force the A.E.C.'s licensing apparatus to revise its safeguard standards. For example, the "as low as practicable" criteria, which in 1971 drastically changed the philosophy of radiation protection, is the result of such actions. However, additional costs imposed by stricter environmental safety standards should be seen as part of normal production costs, and hence eventually subject to reductions due to learning.

— Others apparently consider that nuclear reactor technology can never be a reasonable way to produce electricity. They argue that whatever the increase in safeguard requirements, the potential dangers inevitably associated with nuclear power development are unacceptable. To those people the "net social value" of reactor technology is negative.

The arguments they have developed to support this second view are well known: Large scale development of nuclear power increases the risk of a major nuclear catastrophe; the management and storage of radioactive wastes will generate problems, the solutions of which are far beyond our present and likely future capabilities. Development of nuclear power on a world-wide basis means abundant Plutonium 239 to build nuclear weapons, thereby increasing dramatically the risk of a nuclear violence.

The American administrative and judicial processes afford both sets of critics ample opportunity to impede the rate of reactor commercialization. The principle consequence has been dramatic cost increases. The extreme critics of nuclear power have been at least partially successful in their efforts to force a downward re-evaluation of the social value of reactor technology.

This is the real point about the relationships we have discovered between licensing delays and cost increases. The problem here is not administrative or technical in the sense that a somehow inefficient set of regulatory machinery has caused "artificial" cost increases. Rather, the regulatory process has been used as a device to give effect to the view that reactor technology is not as valuable to society as the anticipated cost of electricity from the first-generation plants implied. The process by which opponents of nuclear power are trying to establish their views about the ultimate value of nuclear power to society is causing delays and costs which obviously can only be reduced by a reduction in the level of the controversy itself.

Politics May Enhance Interfuel Competition

One very important implication of this interpretation is that engineering estimates of reactor capital cost are insufficient guides for predicting actual future costs. Second, as we discussed previously, a major consequence of this situation is an increased potential relative competitiveness for coal-fueled plants. Therefore, if present trends continue, it may turn out that in practice significantly fewer reactors than scheduled will be built in this country, because they will be challenged, on strict economic grounds, by an alternate technology.

The possibility of an effective competition between the two technologies depends, however, upon the future of the coal industry. It may be extremely naive to suppose that the long-term price of coal will remain very much below that of oil in terms of $/million B.t.u. Informed observers of the coal mining industry in the U.S. agree that the combination of environmental protection demands and union wage demands is virtually certain to bring about large increases in the cost of coal.

In addition, social costs are today associated to coal-fueled plant operation, and it is still difficult to assess how much higher generating costs from coal plants should be, to take properly into account these social costs.

In fact, the most disturbing aspect of the whole energy supply system is the absence of any force operating to keep costs stable, except some modest decline in demand when prices rise. Still, this should be small comfort for the nuclear industry. The economic advantage of reactors over coal- or oil-fired plants is based upon a fuel cycle cost advantage which is in great danger of being offset by the capital cost differential between the two technologies.

Our interpretation of the relationship between nuclear reactor cost increases and licensing has highlighted the fact that the issue here is not merely technical or economical, but is inherently political: Present trends in nuclear reactor costs can be interpreted as the economic result of a fundamental debate on nuclear power within the U.S. community. Beyond its economic effects, the real issue of this debate is the social acceptability of nuclear power; any discussion on the future possible contribution of nuclear energy to our country's energy supply system would be, therefore, entirely misleading without recognizing this reality and its technical, economical and social implications.

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They are coauthors of "The Breeder Reactor in the U.S.: A New Economic Analysis," which appeared in the July/August, 1974 *Technology Review.*

Marie-Paule Donsimoni, who holds a graduate degree in economics from the University of Paris, and **Robert Treitel,** who holds a graduate degree in Statistics and Economics from the University, are research staff members at M.I.T.'s Center for Policy Alternatives.

The internal combustion engine is inherently efficient, but the demands of driving and the nature of today's automobiles degrade that efficiency

Testing an automobile on the high-speed oval track at Chrysler Corporation's Chelsea, Michigan, proving grounds. Such testing has enabled a much deeper understanding of how the mechanisms of the automobile behave under real-life driving conditions. (Photo courtesy Chrysler Corporation, Andy Sacks.)

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The Automobile as an Energy Converter

About 30 per cent of the petroleum consumed in the United States is used by automobiles and about 12 per cent by trucks. A marked improvement in the efficiency with which automobiles convert the chemical energy of gasoline into vehicle motion could result in a substantial, although not overwhelming, decrease in our total petroleum requirements. In this article I will examine some of the principal factors that affect the efficiency of gasoline usage by the automobile.

Today's Internal Combustion Engine

The gasoline engine (internal combustion or IC engine) changes chemical energy into mechanical via the Otto cycle, as illustrated in the pressure-volume diagram on page 28. The air-fuel mixture is compressed, burned at constant volume and expanded to give mechanical energy. The so-called "compression ratio" is the volume of gas before compression, divided by the volume after compression. For present vehicles the maximum temperature of the gases in the combustion chamber at the conclusion of the burning process is about 4500°F. The ideal process is better illustrated by the temperature-entropy diagram on page 29.

The efficiency of the gasoline IC engine is enhanced by increasing the compression ratio because greater compression produces higher pre-combustion temperatures, and thus more useful work. In practice, the extent to which one can increase the compression ratio in a carbureted engine is limited by the tendency of the engine to "knock": During fuel combustion in an operating gasoline engine the last fraction of the fuel-air mixture to burn in a cylinder is raised in temperature before combustion by further compression from the combustion of the first part of the fuel to burn. In a knocking engine this last part of the fuel to burn detonates because of the existence of pre-flame oxidation products (such as peroxides) of the fuel that were produced as a result of its high temperature. For high-octane gasolines these pre-flame reactions are minimized, and high compression ratios can be realized. The addition of small amounts of tetraethyl lead to gasoline can markedly increase its octane number and allow the use of a higher compression ratio than would be possible with unleaded fuel.

Diesel engines circumvent octane limitations and achieve high thermal efficiencies by compressing air using a high compression ratio — from 14 to 22 vs. about 8.5 in today's IC engine. Fuel is injected into the very hot compressed air, and if the fuel possesses the proper characteristics (high cetane number, as a gasoline's high octane number), it burns rapidly as it is injected, producing a burn somewhere between a constant volume burn and a constant pressure burn.

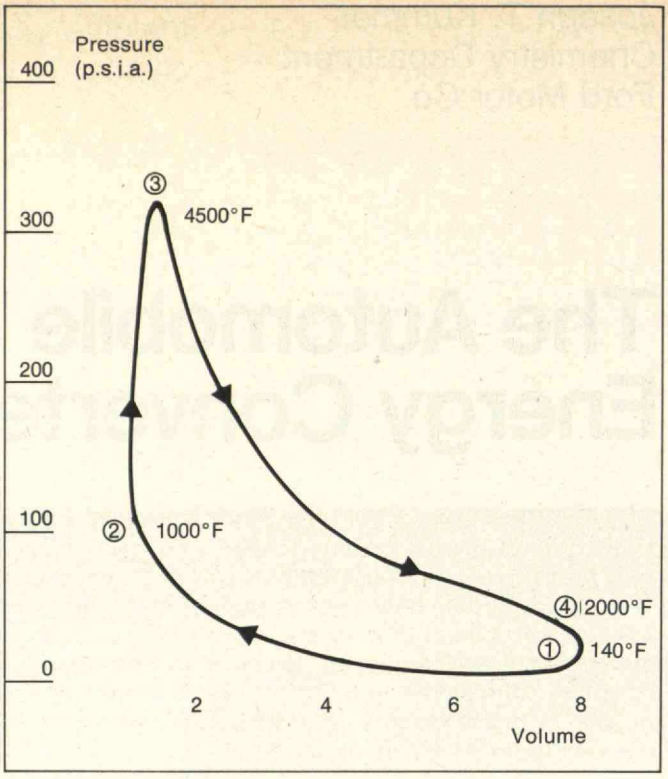
Fuel Economy No Better Than In 1930s

Despite a gradual increase in the average engine compression ratio and engine operation efficiency since 1930, due to the availability of higher-octane fuels, there has been a gradual decrease in *average* vehicle fuel economy from about 15.4 mpg in 1936 to 13.5 in 1972. This fuel economy decrease stems from the use of larger engines (more power per vehicle weight); heavier and larger vehicles; such accessories as automatic transmission, power steering and air conditioning; and higher vehicle speeds. Vehicle design in these years was not directed primarily to fuel economy improvement, but to improved convenience and performance. The advent of lower compression ratio engines in 1972 in order to accomodate lead-free gasoline, the use of various emission control strategies, and an increase in vehicle weight because of safety requirements have resulted in a substantial loss of fuel economy in vehicles produced in the last few model years.

Unfortunately for engine efficiency, we seldom operate our vehicles at maximum power where we can obtain higher thermal efficiency. For instance, one study estimates that we use maximum power only about one per cent of the time, and 43 per cent of the time use less than 10 per cent of engine power. Of course the reason for this extra power is that we feel it necessary to have access to it for adequate vehicle performance. Thus, we use engines that can supply 100 horsepower at the rear wheels when needed. Yet during constant speed, level road driving or during low-power acceleration, which constitute the majority of our driving, the engine need supply much less than this — for example only about 20 horsepower to travel 60 m.p.h..

This requirement for the ability to handle extreme-but-infrequent peak loads is common to many systems (e.g. people, power plants). Unfortunately, in the case of the IC engine as we use it today, this operating mode results in a degradation of the thermal efficiency, because the engine as used exhibits poor fuel economy at low power conditions. The power delivered by the engine at any speed is regulated by controlling (throttling) the amount of air-fuel mixture that enters the cylinder before the compression stroke. In a throttled engine the intake manifold pressure is below atmospheric pressure.

The loss in efficiency at part throttle has three causes. One is the mechanical friction of the large (for maximum



The Otto cycle used in the internal combustion engine is diagrammed here as a cylinder pressure — cylinder volume diagram. From 1 to 2 gasoline and air injected into the cylinder is compressed; from 2 to 3 combustion is taking place, and from 3 to 4 the resultant hot gases are expanded to give mechanical work. The engine diagrammed here has a compression ratio of 8.0, an air-fuel mixture intake at 140 degrees F. and 9.7 p.s.i. (part throttle).

horsepower) engine run at moderate speeds; second is the energy required to pump all the intake air past the partially closed throttle plate into the low pressure intake manifold; and third is the larger fraction of the heat of combustion rejected to the cylinder walls at part throttle. This degradation of thermal efficiency at typical part-load urban driving is shown in the top table on page 31.

If we use a smaller engine (lower maximum horsepower) for a given-sized vehicle with a constant ratio of engine speed to vehicle speed, we gain in fuel economy because the friction loss is smaller for the small engine. Also, we have to operate at higher intake manifold pressures for the same vehicle and engine speed in order to obtain the required power output and consequently incur lower pumping and heat losses. The vehicle with the small engine will of course have poorer acceleration performance because of lower peak power.

The stratified charge engine represents an experimental concept which could operate more efficiently under part-load conditions. One version of the stratified charge engine does not throttle the input air and, this plus a lower specific heat due to lower temperatures, gives a 30 per cent better fuel economy than the same engine throttled, under typical part-load operation. This engine compresses air and regulates the power output by controlling the amount of fuel injected into the cylinder during the compression stroke. The air-fuel mixture is localized (stratified) so that it will be concentrated enough to burn, and is spark ignited.

The energy required for the Environmental Protection Agency's (E.P.A.) typical urban driving cycle with its many stops and accelerations is approximately proportional to the vehicle weight. The work required to move a 2440-lb. vehicle through this type of driving cycle is 0.23 horsepower-hours per mile at the rear wheels, while the work to move a 4550-lb. vehicle through the same cycle is 0.40 horsepower-hours per mile.

As is well known, if one is concerned solely with fuel economy in urban driving and not with performance, one should use a small vehicle with a somewhat underpowered engine (as compared to conventional U.S. practice) with no accessories.

But for highway driving, vehicle weight is of less importance, since the predominant loss is due to aerodynamic drag — the turbulence of air flowing past the automobile's body. The two most important aspects of this drag are the frontal area and a value called the coefficient of drag (C_D), a measure of the car's wind resistance. The work to move a vehicle at a high speed through a given distance can be approximately written as: energy per mile ~ (speed)^2(area) (C_D) (neglecting rolling resistance at high speed).

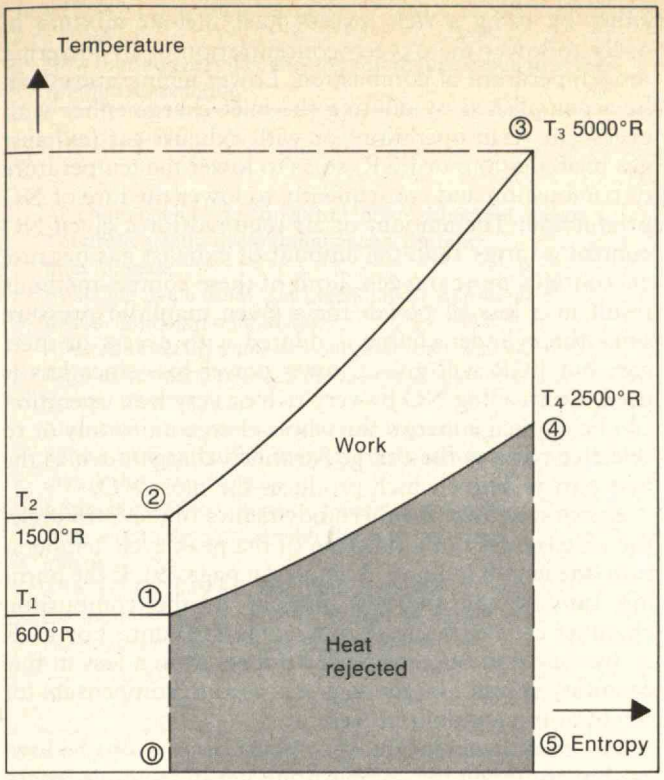
If we desire good fuel economy during highway driving, we require a vehicle of small frontal area of good aerodynamic design with low drag coefficient. This vehicle must, of course, meet the government safety and emission requirements.

The work required to drive a mile for highway driving increases greatly with speed. However, the observed fuel economy does not decrease so abruptly with increased speed because of the increased efficiency of the engine when operated at the higher power levels required for the higher speeds. The exact interplay between these two factors depends upon the ratio of engine maximum power to vehicle weight. The compensation for the higher speed due to increased engine efficiency depends upon how overpowered the vehicle is for the speed range in question.

Other factors such as driving habits, traffic patterns, and tire characteristics are also important in determining the fuel economy of vehicles.

Transmissions and Economy

The transmission in present vehicles attempts to match the variable engine speed (depending upon power requirements) to variable vehicle speed from 0 mph to high speed. Modern automatic transmissions are a compromise among performance, efficiency, and cost. In



A temperature-entropy diagram for the Otto cycle. Any heat engine must reject a certain amount of heat to the environment. The area under this curve represents the total heat energy of the system, and the shaded area the waste heat. The line 1-2 is the compression, 2-3 is the constant volume combustion, and 3-4 is the expansion to produce mechanical energy. In the ideal engine,

$$\text{efficiency} = \frac{T_2 - T_1}{T_2} = \frac{T_3 - T_4}{T_3} = 1 - \left(\frac{1}{R_c}\right)^{R/Cv}$$

where R_c=compression ratio, R=gas constant, C_v=specific heat of working gases at constant volume.

urban driving they may be only 75 per cent efficient because of losses in the fluid torque converter, although in highway driving they exhibit high efficiency. If the transmission were more efficient in urban driving, and if it could provide a better match between the engine speed and vehicle speed, there would be a large gain in fuel economy, perhaps in the ideal case as much as 50 per cent for a vehicle with a large engine in urban driving. An ideally matched engine and transmission would mean an efficient, infinitely variable transmission that would allow the engine to run at a low speed and consequently high intake manifold pressure for the power load required. Thus, as low a friction and pumping loss as possible would be incurred. In the past the overdrive gear was used to lower the engine operating speed manually and to effect an economy gain in highway driving. For the same reason a low rear axle gear ratio (the ratio of motor speed to wheel speed) can result in better fuel economy, but at the same time poor acceleration.

Much effort has been spent in the last 70 years to develop improved transmissions. Present automatic transmissions offer great convenience at low cost but until now the economics have not encouraged the added costs probable for a fuel saving transmission. The fuel cost for 50,000 miles can be about $1000 if fuel costs 30 cents per gallon, but will be about $3000 if fuel costs $1 per gallon. A transmission designed to give a 10 per cent increase in fuel economy may only just pay for its purchase price in 25,000 or 50,000 miles at the lower fuel cost, but could result in a net gain to the buyer at the higher fuel prices probable in the future.

Combustion and Fuel Savings

The combustion of a fossil fuel with air is a basic step in any heat engine. Today, because of the 1977 federal emission requirements (0.41 grams per mile of hydrocarbons and 3.4 grams per mile of CO for the 100 to 300 grams of fuel burned per mile), we must, during the E.P.A.'s prescribed driving cycle, combust 99.8 per cent of the hydrocarbons and have a chemical heat release of about 99 per cent in the engine together with the afterburner. Ideally, this system performance should be capable of being maintained for 50,000 miles.

The fast propagation of a turbulent flame is the essential part of all heat engines. For high-speed operation of the IC engine the flame must travel the length of the combustion chamber in a few milliseconds. This requires a flame speed of about 10 to 30 meters per second. Laminar or quiescent flame speeds are a few tenths of a meter per second. By increasing the turbulence of the gas before combustion, the required flame speed can be obtained. The very high turbulence level of the gas in the cylinder is caused principally by the fast inrush of air during the intake stroke and increases with engine speed to provide the required higher burning rate at the higher speeds. The turbulent flame speed, which is a function of the adiabatic flame temperature as well as of the turbulence, decreases for low combustion temperatures such as those caused by high air-to-fuel ratios (lean operation), by low inlet manifold pressures (part-throttle operation, which leads to dilution by the residual from the previous charge), by exhaust gas recirculation (an emission control procedure for nitrogen oxide reduction), and by the use of aliphatic fuels as compared to aromatic fuels. Aliphatic fuels are those composed primarily of straight-chain hydrocarbon molecules with single-carbon carbon bonds. They burn slower because of lower flame temperatures. Aromatic fuels contain molecules featuring carbon chains in rings with double bonds and burn faster because of higher flame temperatures.

If the fuel charge burns too slowly, the fuel economy can be greatly decreased, since expansion of the burned fuel through the compression ratio cannot take place. Some compensation for a low rate of burn can be ob-

tained if the spark timing is increased to allow a longer time for the combustion process, or a faster burn rate can be obtained if the air and fuel-induction system is changed to increase the gas turbulence. The intentional and unintentional variations in flame speed that have resulted from pollution control measures have led to a greater need for understanding this subject than has existed in the past.

The flame speed problem is further complicated in the spark-ignited IC engine by the existence of a statistical variation of flame speed from cycle to cycle (cyclic dispersion). No two cycles are alike, as shown on page 33 by the pressure-crank angle traces for 16 consecutive cycles of an engine. This effect lowers the tolerance of the engine for lean operation and increases the octane requirements. In an engine with a well-designed ignition and induction system the basic cause of cyclic dispersion appears to be related to the statistics of turbulence so that it may not, in fact, be possible to eliminate this dispersion. However, after we understand cyclic dispersion better, we may be able to minimize it, and the gain in engine performance could be translated into increased fuel economy.

The basic chemistry and hydrodynamics of flames have received a large amount of scientific attention; yet there is no universally accepted theoretical model of turbulent flames or of the quench thickness of a turbulent flame impinging against a cold wall. There has recently been an increase in interest in this area. The quench thickness is an important value which in part determines the hydrocarbon emissions of an engine. The auto engine depends upon the ability of highly turbulent flames to combust the air-fuel charge in the cylinder in the required time (a few milliseconds or 40 or 50 crank-angle degrees) and at the same time produce low emissions.

The Pollution Constraint; Present IC Engines

Prior to 1966 exhaust pipe emissions of vehicles were uncontrolled. California in 1966 and the Federal Government in 1968 required control of hydrocarbons and carbon monoxide. The 1970 amendment to the Federal Clean Air Act required for the future, a further ten-fold decrease in emissions of CO, hydrocarbons, and nitrogen oxides (NO).

The pollution constraint is important in the energy problem inasmuch as many of our emission control procedures result in a loss of fuel economy. But why is this? First, we examine the case of nitrogen oxide.

Controlling Nitrogen Oxides

NO is formed in the cylinder of the Otto cycle engine by the high-temperature (2800°K.) reaction between oxygen atoms and nitrogen molecules. Its formation is expressed as:

$$N_2 + O \rightarrow NO + N$$

$$N + O_2 \rightarrow O + NO$$

NO is not formed at a uniform rate throughout the combustion chamber, for the temperature in the cylinder after combustion is not uniform. The first part of the air-fuel mixture to burn is the hottest after combustion is completed, because of all the burned gases it is compressed the most as a result of rising cylinder pressure during the approximately constant volume burn of the charge. Consequently, this first part produces the most NO.

The formation of NO can be controlled in the engine either by using a rich (excess fuel) fuel-air mixture in order to lower the oxygen concentration or by lowering the temperature of combustion. Lower temperatures can be accomplished by diluting the inlet charge either with excess air (lean operation) or with exhaust gas (exhaust gas recirculation, or EGR) so as to lower the temperature of combustion and consequently to lower the rate of NO production. The amount of air required for a given NO control is larger than the amount of exhaust gas because air contains more oxygen. Both of these control methods result in a loss of power for a given manifold pressure since the cylinder charge is diluted with excess or inert gas; but EGR will give a lower power loss since less is used. Controlling NO by very rich or very lean operation can be applied either to the whole charge uniformly or to selective parts of the charge (stratified charge) such as the first part to burn, which produces the most NO.

As we saw from the thermodynamics of the Otto cycle, the efficiency is not a function of the peak cycle temperature (the length of line 2-3, figure on page 29). If the burning rate of the fuel-gas mixture in the combustion chamber can be preserved, the method of control by EGR or by very lean operation need not result in a loss in fuel economy unless a larger engine is used to compensate for the loss in maximum power.

The peak temperature of combustion can also be lowered by initiating the combustion later in the cycle (spark retard) so that combustion takes place in part during the expansion stroke. This results in a combustion process that approaches constant pressure rather than constant volume. Since the working gas can hold more heat at constant pressure than at constant volume per degree Centigrade, peak temperature is lowered and, as a result, the rate of NO production decreases. This type of operation does not allow full expansion of the burned gases, since part of the charge is burning during the expansion stroke and results in a loss in fuel economy and power. In 1973 and 1974 vehicles, some NO control was obtained by spark retard; but the retard was used primarily, as will be seen later, for hydrocarbon control. We do not know of any homogeneous reactions that can be used in practice to unfix NO (that is, to convert it back to N_2 and O_2) in the exhaust system of a vehicle under normal urban driving conditions (exhaust manifold temperatures 500-600°C).

Carbon Monoxide

If an IC engine is run with less air than required for complete combustion (rich), it is a thermodynamic certainty that the exhaust gas will contain some reducing agent, which is predominantly CO. If the vehicle is run with excess air, the experimental result is that the per cent CO in the exhaust will be low — close to the government limits of 3.4 grams per mile for an average U.S. vehicle. The Federal test procedure requires that the emissions of CO, NO, and hydrocarbons be measured over the duration of the 15-mile test run from the moment the ignition key is turned on. A cold engine requires the introduction of considerable excess fuel into the intake manifold (choke), because of fuel volatility problems, in order to start properly. This leads to high CO and hydrocarbon emissions for the first minute or two of the cycle (46 min. total driving time in concept) and results in the necessity for very low values for the remainder of the cycle in order to meet emission requirements.

Control methods for CO in the engine which are based

How thermodynamics and friction reduce mileage in the real-life automobile

	Thermal efficiency (per cent)	Miles per gallon
All chemical energy converted into mechanical energy	100	194
Theoretical Otto cycle (ideal gases, perfect heat release)	57	116
Real Otto cycle (heat loss dissociation, non-ideal gases, indicated efficiency)	33	68
After subtracting pumping losses at road load, 40 m.p.h.	23	44.6
After subtracting mechanical losses (engine friction) at road load, 40 m.p.h.	17	33
After subtracting carburetor metering, choke, accelerator pump, fan, manifold distribution, and distributor retard losses	15.5	30
After subtracting automatic transmission losses	11.9	23
After subtracting power steering and generator losses	10.3	20
After subtracting air conditioning losses (1.5 h.p. continuous) (Air conditioning requires higher idle speed and is used only at certain times	8.5	16.4

The ideal "gas-burner" could get an equivalent of about 200 miles per gallon, but far less is realized in actual Otto cycle, internal-combustion-engine autos, because of thermodynamic limitations and internal friction in engines. The automobile used in these calculations is a 1971 Ford Pinto; 2000 c.c., 4-cylinder engine with automatic transmission. The vehicle is assumed to have run through the standard urban driving cycle specified by the Environmental Protection Agency, and to have run on gasoline with an energy content of 44.6 horsepower-hour per gallon.

Federal automobile exhaust emission standards (grams per mile)

	Hydrocarbons	CO	NO_2
Pre-1968 (uncontrolled)	15	90	6
1968-1972	6.3 → 3.0	52 → 28	uncontrolled
1973-1974	3.0	28	3
1975 (interim standards)	1.5	15	3.1
1976	1.5	15	3.1
1977	0.41	3.4	2.0
1978	0.41	3.4	0.4

Present schedule for reducing automobile pollution amounts to an approximate 97 per cent reduction in hydrocarbon and carbon monoxide from uncontrolled levels by 1977; and a 93 per cent reduction of nitrogen oxides by 1978. The National Academy of Sciences/ National Academy of Engineering has reported that the 1977 standards are achievable, and the 1978 standards "can probably be achieved" if problems with advanced emissions control catalysts can be solved.

on lean (excess air) operation should not result in a loss of fuel economy if the rate of burn of the charge is preserved. It will result in a loss in power as compared to conventional operation at near stoichiometric air-fuel ratio; and if this necessitates a larger engine, it can result in lower fuel economy than in a smaller engine run lean. I will consider CO control in the exhaust system later.

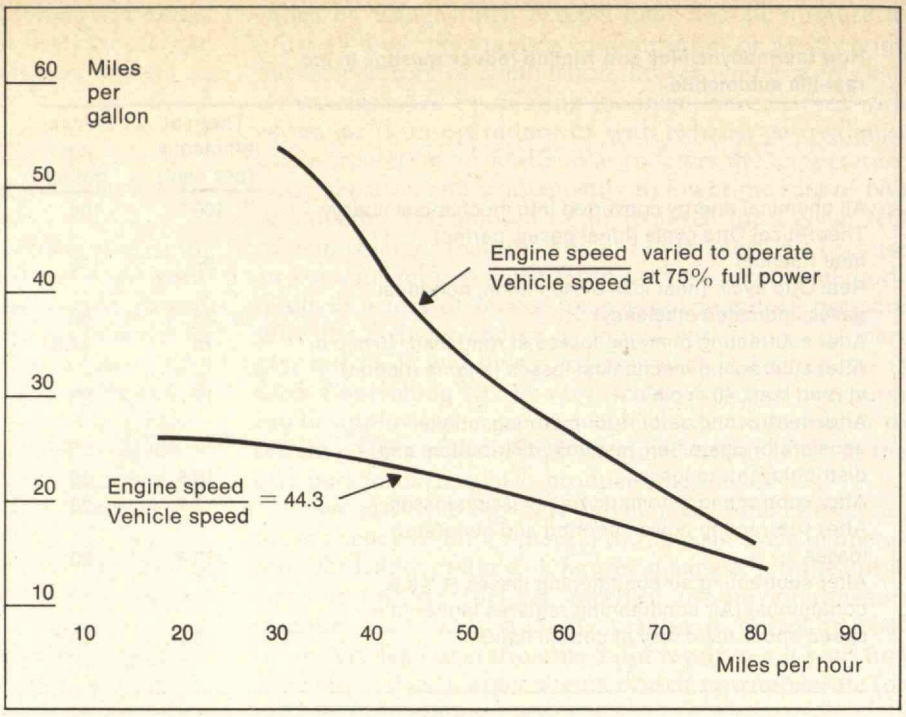
Hydrocarbons

The principal cause for the loss in fuel economy is the necessity for hydrocarbon control. Although the gases in the IC engine are hot (2800°K), the walls are cold (100-150°C). This is a very great advantage, since we can use cast-iron fabrication and retain an oil lubricant on the cylinder walls. The flame that brings about the combustion of the air-fuel mixture is extinguished (quenched) a few thousandths of an inch from the cold wall. This quench layer is cooled by the wall and contains unburned fuel. In addition, the fuel-air mixture is forced alongside the piston and back of the top compression piston ring during the compression stroke; and this fuel does not burn during the main combustion process. During the expansion stroke the ring area hydrocarbons escape and form a layer on the cold cylinder wall. During the blowdown process, when the exhaust valve opens, the hydrocarbon quench layer on the cylinder head is drawn out in the exhaust gases; and during the exhaust stroke the hydrocarbons from the ring area are scraped from the cylinder wall and find their way into the exhaust gases. Enough survive postquench oxidation to be the source of unburned hydrocarbon emissions for an engine with correct flame speed.

Under urban driving conditions our present IC spark-ignited engines will have, without secondary treatment, hydrocarbon emissions in excess of the 1977 law when used in present vehicles. Combustion chambers with small surface-to-volume ratios will minimize hydrocarbon emissions. To meet emission standards they must be removed in some post-quench oxidation process. This can be either homogeneous or catalytic oxidation. The homogeneous oxidation requires excess oxygen and temperatures above 700-800°C. The excess oxygen can be provided by either lean operations or an air pump.

Homogeneous Oxidation — The Thermal Reactor

Unfortunately, the exhaust temperatures of our present engines are not high enough in the exhaust manifold (500-600°C) during urban driving to oxidize the quenched hydrocarbons in the exhaust process or exhaust manifold well enough for emission control. This is particularly so with EGR or lean operation or engines with very high indicated thermal efficiency which will result in



The ideal transmission could vary infinitely to operate an engine at the most efficient speed for each vehicle speed. This graph shows the difference such a transmission could make in mileage. The limitation of 400 r.p.m. engine speed does not permit operation at 75 per cent of full power below 30 m.p.h. (Source: Jandasek, SAE Transactions, *61*, 95 (1953))

a colder exhaust. Higher temperatures that can give some measure of hydrocarbon control can be obtained by spark retard and/or by enlarging and insulating the exhaust manifold.

Spark retard results in lower thermal efficiency and consequently higher exhaust temperatures since less thermal energy is converted to work.

By insulating and enlarging the exhaust manifold the residence time at elevated temperatures of the exhaust gases can be increased, and homogeneous hydrocarbon oxidation will occur. This thermal reactor approach has been extensively investigated, since it offers the hope of less spark retard for a given hydrocarbon control. It suffers from a severe materials problem in the construction of the holding chamber (enlarged, insulated manifold), which can operate at times during high-speed driving or during engine malfunctions in excess of 1000°C.

Conservation of the exhaust heat by lowering the heat rejection rate from the cylinder and exhaust port to the cooling water can increase exhaust temperatures a limited amount without loss in fuel economy and will therefore result in less spark retard and better fuel economy for a given hydrocarbon emission level.

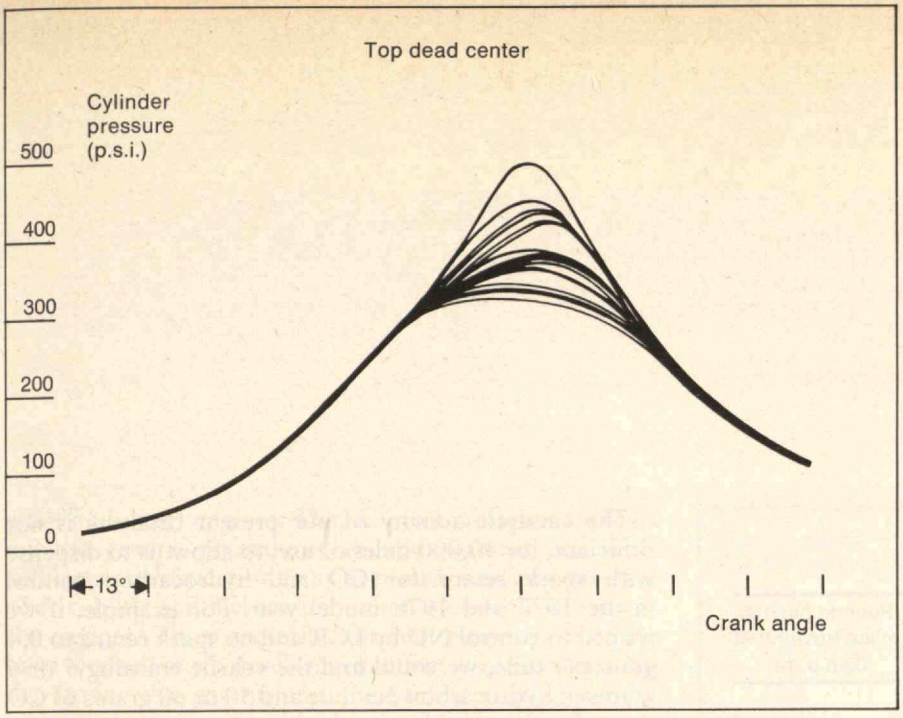
Unfortunately, methods for CO and NO control, as we have seen, produce cooler exhausts as a result of the excess air or the use of EGR. In addition, they produce a cooler flame in the cylinder, which results in thicker quench layers and a larger fraction of the fuel contained in the cylinder residing in the quench areas. This results in larger hydrocarbon emissions from the engine and requires more spark retard in order to attempt to control these.

A stratified charge engine in which only air is compressed and the fuel is injected into the cylinder some time during the compression stroke and ignited subsequently by a spark can, *in theory,* avoid the ring area and wall quench hydrocarbons.

Catalytic Exhaust Gas Treatment

Attempts, unsuccessful so far, to meet the low emission standards now scheduled for 1978 (see bottom table, page 31) with present engines by using exhaust gas recirculation and spark retard for NO control, and spark retard for hydrocarbon control, have resulted in a vehicle with very low power, driveability, and fuel economy. In most 1975 cars' exhaust gases are treated catalytically after they leave the engine at normal exhaust temperatures because catalysts can be very efficient above 250-350°C. Thus pollution control is effected without making large changes in engine operating parameters. The result is a vehicle with greater fuel economy and driveability. The use of catalysts, however, requires the use of unleaded fuel in order to obtain the required catalyst durability. The unleaded fuel available today has an octane number of 91 rather than the 95 to 98+ available as leaded fuel. The vehicles designed to run on unleaded fuel have a lower compression ratio than those that formerly used leaded fuel (about 8-8.5 as compared to 9 or 10) and consequently have a somewhat lower thermal efficiency.

The catalytic approach to emission control of all three pollutants consists of the reduction of NO to N_2 using CO or H_2 and by catalytic oxidation of CO and hydrocarbons to CO_2 and H_2O. In order to provide the reducing atmosphere for NO reduction, the engine must be run with a slight excess of fuel over the stoichiometric requirement. Air from an air pump (the air pump may result in a three per cent fuel economy penalty) can be added between the NO reduction catalyst and the oxidation catalyst so as to provide the necessary oxygen for the catalytic oxidation of CO and the hydrocarbons. The production of NH_3 by the NO reduction catalyst must be avoided because this can be quantitatively oxidized back to NO by the oxidation catalyst. There are, of course, numerous variations on the catalytic approach to emission control. One can, for example, reduce NO by very lean operation or EGR and only use the oxidation catalyst for CO and hydrocarbon reduction.



Internal combustion cycles can be as unique as snowflakes as shown by this graph of 16 consecutive cylinder pressures as they go through part of the internal combustion cycle.

The scientific literature contains numerous examples of catalysts that can oxidize CO or hydrocarbons and reduce NO in the appropriate temperature range,so that we should expect, from a scientific point of view, to be able to treat exhaust gas. In practice, however, we have encountered severe problems of durability. Because of the high CO and hydrocarbon emissions during the cold start, the catalyst must achieve a high efficiency of CO and hydrocarbon control in less than 60 seconds from the vehicle start. This requires good catalytic activity at an inlet catalyst temperature of 250°C to 350°C; and yet the catalyst must not lose this activity after use at other engine operating conditions, such as high-speed operation which can lead to catalyst temperatures near 1000°C. This wide operating range is difficult to achieve. At the high peak temperatures all catalysts deactivate, which causes sintering and loss in surface area. Deactivation can also be caused by catalyst poisons in the exhaust such as lead, sulfur dioxide and phosphorous compounds. Even the 0.03 to 0.05 grams of lead per gallon of gasoline that may in practice be found in lead-free gasoline will poison catalysts. In addition, during some abnormal engine operating conditions, usually of short duration, the air-fuel mixture does not burn in the cylinders but does burn on the hot catalyst, producing temperatures of 1200-1400°C or higher, which destroy the catalyst.

In the 1975 model year, most vehicles will employ catalysts of noble metals for CO and hydrocarbon control, principally platinum and palladium (about 2 grams per vehicle), supported on high-surface-area alumina in order to extend the noble metal surface area. The automobile companies are required by law to sell vehicles designed, built, and equipped for their useful life to meet the federal emission requirements. It is in their interest to use the catalyst with the highest performance. As of now, the available data indicate that catalysts containing noble metals have high activity and durability for auto exhaust service.

The surface area of the alumina can be stabilized toward thermal sintering by proper preparation and by presintering at elevated temperature before the addition of the noble metal. Although the noble metal dispersion on the catalyst can be made nearly atomic before use, the metal atoms agglomerate during use at elevated temperatures (500-1000°C) to an average size of several hundred angstroms in diameter. In this size range only 10 per cent or less of the platinum atoms are surface atoms and are effective for catalysis. If this agglomeration could be prevented, the platinum usage could be lowered.

The catalytic activity of base metal oxides for oxidation of hydrocarbons and CO is lower than that of the noble metals per unit of surface area. These base metals include copper, cobalt, chromium, nickel, manganese and iron. The increased surface area of the base metal oxide required for it to compete with platinum can in some cases be obtained by depositing the oxide on a high-surface-area support such as alumina. The base metal oxide should not react with the alumina, since the product is often less active than the oxide, nor increase the sintering rate of the alumina. The particulate matter produced by abrasion of the catalyst particles and blown out of the exhaust should not present a health hazard. The catalytic activity of many base metal oxides is severely depressed at temperatures below 500 to 600°C by the approximate 20-30 parts-per-gallon of SO_2 found in the exhaust produced from sulfur in the fuel. This depression in activity is a result of the high thermal stability of the base metal sulfates which form on the surface of the base metal oxides and are poor catalysts.

Base metal catalysts that could perform as well as noble metals in auto exhaust service are desirable because there are now only two large reserves of noble metals available to the U.S. (U.S.S.R. and South Africa); and there is always a risk that foreign supplies could be cut off because of political reasons. The automotive use of noble metals may double or triple the present annual use of noble metals in the U.S. (about 430,000 troy ounces per year in 1971).

The weight of various automobile energy storage methods

	Pounds per 100 miles traveled at 30 h.p.-hr.
Gasoline (Otto cycle)	44
Thermal energy (lithium fluoride)	500-1,000
Flywheel (steel)	3,000
Rubber spring	4,000
Hydraulic	15,000
Batteries	
(lead-acid)	4,000
(sodium-sulfur)	400

Chemical energy storage for the automobile (equivalents to 20 gallons of gasoline)

	Weight of fuel and container (lbs.)	Volume of fuel (cu. ft.)
Gasoline	142	2.67
Methanol	308	5.4
Liquid hydrogen	182	9.4
Hydrogen from:		
Ammonia	424	6.5
Solid magnesium hydride	661	6.6
Liquid C_6H_{12}	729	12.4
Compressed hydrogen at 3,000 p.s.i.	5,000	46

Gasoline, or other such liquid hydrocarbons, remains the automobile energy storage method of choice, when compared with any other mechanical, electrical, or chemical means. Besides the obvious weight and volume advantages shown here, gasoline is relatively benign in terms of its principal combustion products, carbon dioxide and water.

The catalytic activity of our present catalysts is not sufficient, for 50,000 miles of use, to allow us to dispense with spark retard for CO and hydrocarbon control in the 1977 and 1978 model year. For example, if we wished to control NO by EGR and no spark retard to 0.4 gram per mile, we could find the vehicle emitting 5 or 6 grams of hydrocarbon per mile and 50 or 60 grams of CO per mile. To meet the standards of 0.4 g/mile hydrocarbon and 3.4 g/mile CO with this vehicle, we would require a catalyst efficiency for CO and hydrocarbon oxidation of (in view of the cold start problem) greater than 95 per cent throughout 50,000 miles of use for all vehicles. As of now, this is not attainable. A value of 50-70 per cent for hydrocarbon oxidation would seem more realistic.

If the air-fuel ratio of the engine can be kept at the stoichiometric point with one per cent accuracy by use of an air-fuel sensor in the exhaust together with some feedback circuit, then both NO reduction and CO and hydrocarbon oxidation can be done in one catalyst bed instead of two separate catalytic beds. The disadvantages and advantages of such a system with respect to catalyst durability are being investigated.

Alternate Power Plants

There are a number of incentives for developing alternate power plants for vehicles. We might like an engine with higher part-load fuel economy, reduced pollutant emissions, of lighter weight, of longer durability at a lower cost, and less noise emission; or we may want to develop a power plant compatible with a new fuel. The development of a new power plant to the point of production is a long and costly procedure. The overriding considerations concerning the production of an alternate power plant meeting some or all of the above objectives will be economic, legality over many model years, and logistical in that it must be compatible with projected fuel supplies and existing vehicle size and use patterns. If it is desirable to change present automotive engines substantially, it is estimated that it would take about ten years to convert *all* of the very large and automated production facilities to the new production. This very important decision awaits a better understanding of all our options in this area and of the ultimate level of pollutant control required.

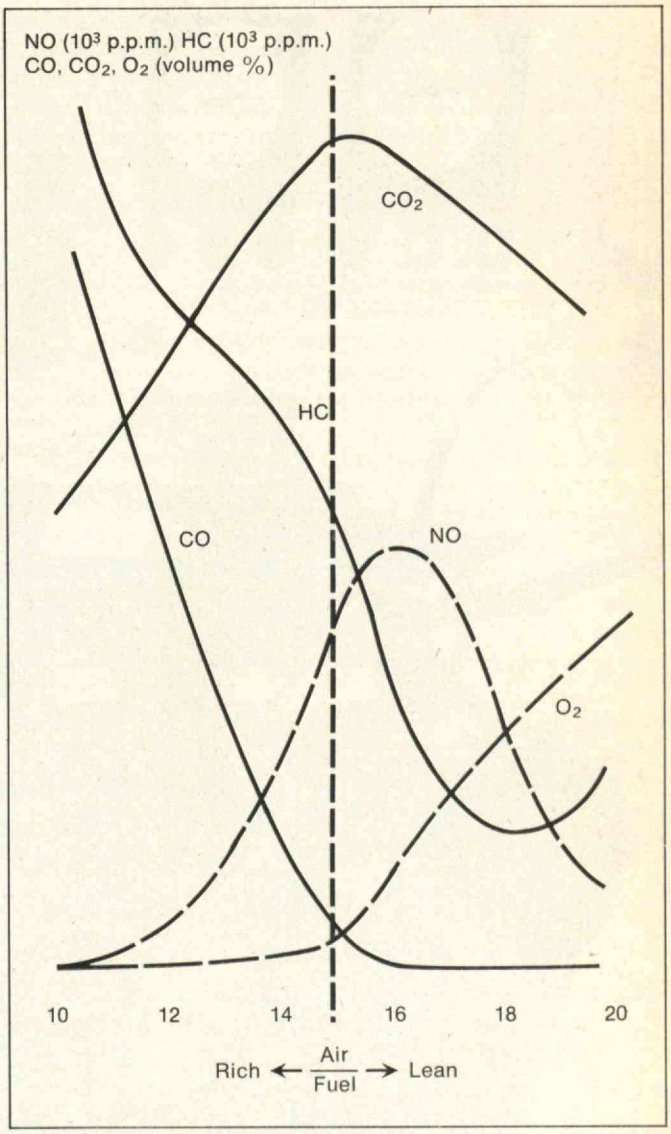
There do exist numerous engines based on modifications of the conventional gasoline engine — offering solutions to the pollution problem to various degrees — including the stratified charge engine, engines with torch ignition and prechambers, Wankel rotary en-

gines and diesel engines. They control pollutants following the general procedures already outlined, but with sufficient sophistication so as to preserve a larger fraction of drivability and fuel economy than is possible with present engines. Three radically different power plants that have received much development effort in recent years are the automotive gas turbine, the Stirling engine and the fuel cell.

A gas turbine engine runs hot (about 1000°C) with a large excess of air. All of the parts in the combustion area, such as the combustor wall, turbine stator, and rotor, run hot; and this engine can be designed to produce very little CO and hydrocarbon emissions. With conventional burners the NO emissions are high; but if there are extensive changes in burner design or catalytic combustion, NO emission can probably be reduced to acceptable values. In a simple cycle the part-load fuel economy is not good, but it is hoped that with sufficiently high inlet temperatures to the turbine of about 1100°C the fuel economy in urban driving will be as good as that of conventional piston engines. The materials of construction of the turbine lead to an economic problem: If the high-temperature parts of the turbine, such as the stator and rotor (which runs at 30,000-60,000 rpm), are constructed of metal, the cost is believed to be too high for automotive applications. For this reason, an extensive effort is being made to develop a gas turbine in which the parts exposed to high temperature are ceramic.

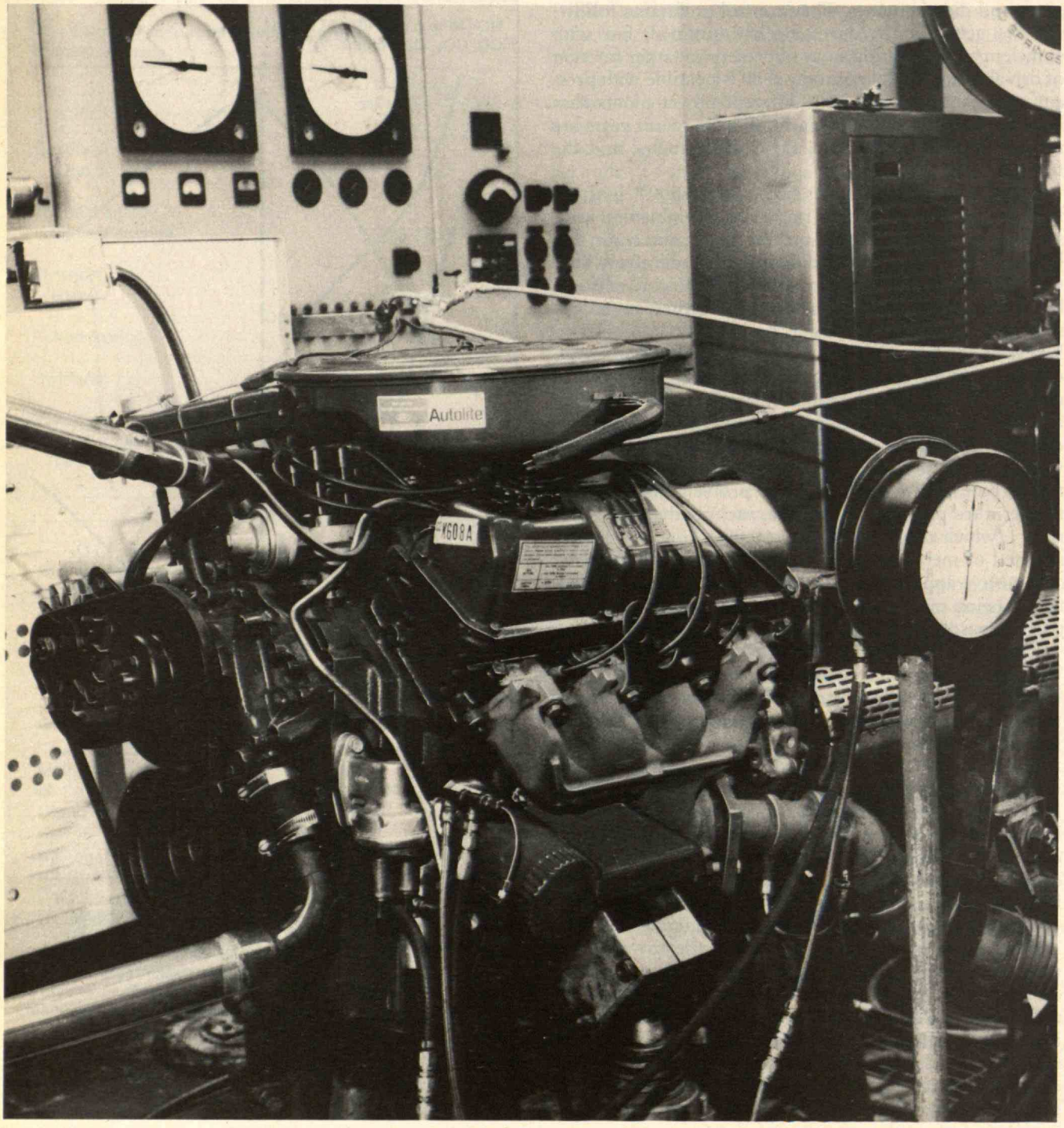
The Stirling engine, which is an external combustion heat engine (nominal heater temperature 700°C) using hydrogen at a high pressure of a few thousand pounds per square inch as a working gas, has been developed over the last 30 years into an automotive engine by Philips Industries of Eindhoven, Netherlands. Power output is regulated by changing the pressure of the working gas. Many believe that a vehicle using such an engine can produce low emissions at good fuel economy. We hope that the cost of production will enable it to be competitive with other solutions of the fuel economy and pollution problem; however, the present engine uses perhaps as much as 100 lbs. of expensive high-temperature alloy steels.

If hydrogen becomes available as a fuel at competitive prices, and if the problems of hydrogen storage in a vehicle are solved in practice, then there will be large incentive to develop fuel cells for vehicle use. The use of hydrogen in a fuel cell will be several times more efficient for vehicle use in urban driving than if the hydrogen were used in conventional IC engines. Fuel cells catalytically combine hydrogen and oxygen to produce electricity, which could



Varying the air-fuel ratio in an engine varies the exhaust constituents as shown in this graph. To make the curves comparable, the units are different for some of the constituents: NO is expressed in thousands of parts per million; hydrocarbons in hundreds of parts per million; and CO, CO_2, and O_2 in volume per cents. Vertical line marks the stoichiometric point — the "ideal" air-fuel proportions for combustion.

A dynamometer at the Ford Engineering and Research Center is used to measure engine power under various experimental conditions. By varying the load on the engine tested, such dynamometers can evaluate fuel economy, horsepower and durability. Other performance factors measured include drive line efficiency, axle strength and stamina and the effectiveness of cooling systems and emission control devices. (Photo courtesy Ford Motor Company.)



then power an automobile. Contrary to the IC engine, the efficiency of the fuel cell is high at low loads and decreases at high loads, which appears to be a better match to our driving patterns than the conventional IC engine. A continuing problem in the development of fuel cells has and will be the development of inexpensive, long-life catalytic electrodes for H_2 oxidation and O_2 reduction.

New energy conversion devices from any source should receive paper study. It usually turns out that while we can conceive of different heat engines with thermal efficiency as good as or better than the IC engine, we usually cannot even come close to devising ones that have the power-to-weight ratio of the IC engine.

Energy Storage and Recovery — Hydrocarbons Effective

An effective means of energy storage is in the form of gasoline or other combustible organic liquids which can be subsequently burned. Both carbon and hydrogen are light atoms, the heat of combustion is high, and the oxidizing agent, oxygen, need not be carried in the vehicle. The combustion products, CO_2 and H_2O, pose no health hazards. Other schemes for energy storage are less efficient, as is evident from the tables on page 34. Storage of energy as macroscopic electric or magnetic fields seems impractical, as does the use of nuclear energy generated in the vehicle.

The development of an efficient, cheap, and lightweight storage battery for electric vehicles would allow efficient transportation use of electric energy generated by nuclear power plants. With a battery such as the sodium-sulfur battery the efficiency of energy utilization will be larger than a process in which hydrogen is generated electrolytically, stored in the vehicle, and used in fuel cells. Such a vehicle will always have a limited range (about 100 miles for 400 lbs. of Na-S batteries). This is because recharging will be slow in practice because of power, heat, and battery-life limitations, and because battery replacement to extend the range, while possible, will be considerably more complicated than the replacement of liquid fuels.

A vehicle during deceleration must lose kinetic energy either to the air, or as tire friction when turning, or in the engine or brakes. In theory, a part of this energy can be recovered, stored, and reused for vehicle propulsion. The amount of deceleration energy available depends upon the driving pattern considered and the driving habits assumed. General Motors investigators estimate that 32 per cent could be recovered in city driving, 10 per cent in suburban driving and two per cent in highway driving. Two engineering problems are associated with recovery of braking energy. First, the efficiency of the recovery, storage, and reuse systems must be high, since it is the product of these three efficiencies that will determine the energy actually reused. Second, the recovery device must handle high power, since the deceleration rate can be as fast as or faster than the acceleration rate. However, the fuel economy loss due to the weight of the device, the cost of the device and vehicle modifications, and its maintenance should be offset by the cost of the fuel saved and possible brake wear saved. As of now, however, no such device appears to have been developed.

So, considering this analysis of energy and the automobile, we are left with two general conclusions concerning the IC engine, and the prospects for improving its efficiency.

First, while the thermal efficiency of the Otto cycle IC engine is good — about 35 per cent — when used at high power levels, the fuel economy is degraded considerably by part-load operation, the convenience of accessories, and high vehicle weight. It is these factors that must be attacked to produce better fuel economy, for while modified and alternative engines do look promising, a great deal of development will be required to make them practical.

Second, our research has shown that improvements in fuel economy are indeed feasible, and that much research and development has already been done on them. However, in many cases, engineering developments that can lead to a better fuel economy await the arrival of sufficient economic benefit to offset their initial cost.

Suggested Readings

"Catalytic Control of Automobile Exhaust Emissions," R. S. Yooles, H. Wise, Critical Reviews in Environmental Control, 2, 125 (1971).

"Emissions from Combustion Engines and Their Control," D. J. Patterson, N. A. Henein, Ann Arbor Science Publishers (1972).

"Alternate Power Plants for Automotive Purposes," E. M. Estes, Proceedings of the Institute of Mechanical Engineers, *186*, 125 (1972).

"The Indicated Performance of Otto-Cycle Engines," R. V. Kerley, K. W. Thurston, SAE Proceedings, *70* (1962).

"Time Resolved Measurements of Hydrocarbon Mass Flowrate in the Exhaust of a Spark Ignited Engine," R. J. Tabaczynski, J. B. Heywood, J. C. Keck, SAE Paper 720112 (1972).

Joseph T. Kummer received a B.E. degree and a Ph.D. degree in chemical engineering from Johns Hopkins University in 1940 and 1945, respectively. He has been a fellow at Mellon Institute for Industrial Research and an Associated Scientist with the Dow Chemical Company. Since 1960, he has been employed by Ford Motor Company, where he is a Senior Staff Scientist in the Chemistry Department. His research interests are ionic conductivity of solids, adsorption, heterogeneous catalysis and the chemistry of IC engine operation. He is a member of the American Chemical Society.

Reducing the average car weight from 3600 to 2000 lbs. can mean a greater than 40 per cent reduction in gasoline consumption, or a 16.3 per cent decrease in total U.S. petroleum consumption — a savings greater than the amount of petroleum currently imported by the U.S.

Recycling is one possible means of reducing the energy required for automobile production. The most optimistic estimate shows a savings of 36 million B.t.u. per car produced from recycled rather than primary materials. If all cars in the U.S. were produced this way, a net savings of 0.45 per cent of the total U.S. energy consumption of 1970 would result. (Photo: Ewing Galloway)

Reducing the Energy Investment in Automobiles

John K. Tien,
Roy W. Clark,
Mahendra K. Malu,
Henry Krumb School
of Mines,
Columbia University

We need not be reminded of the long lines at service stations or the small amounts of gasoline that could be purchased in the fall of 1973 and winter of 1974. Although the extent, the causes, and even the reality of the energy shortage have been and are being debated, the fact remains that we are indeed headed for a very severe shortage. U.S. petroleum resources are rapidly diminishing. At the present production rate of about 22×10^{15} B.t.u. per year, the approximately 460×10^{15} B.t.u. reserves left at the end of 1971 can at best last until 1993. While research on alternate energy sources for the future is crucial, it is imperative that we now follow stringent measures for conserving the energy used today.

Transportation of people and goods in the United States requires a large percentage — about 24 per cent in 1970 — of the total energy consumed by the nation. More importantly, this energy requirement is almost wholly satisfied by petroleum, accounting for about 55 per cent of the nation's consumption of this fossil fuel in 1970. Thus transportation needs are taxing our most rapidly diminishing resource, a resource whose supply, as we have found, is highly sensitive to our relationships with the countries from whom we import larger amounts each year. Transportation, as a large consumer of the nation's energy, offers many possibilities for reducing petroleum consumption, and it is important now that energy conservation be considered as a major design criterion for transportation vehicles.

We are concerned with assessing the feasibility, determining the quantity, and recommending the means by which energy requirements can be reduced in transportation. The private automobile is chosen for the present case study, since automobiles account for 55 per cent of all transportation energy demands, and automobiles' fuel consumption has drastically increased since 1970 with the application of environmental and safety standards.

Energy to Build

The total energy required to construct an average-size car can be estimated by summing up the various energy requirements: mining, materials production, manufacturing and shipping, to name the most important.

The materials composition of a typical car, which has an average weight of 3600 lbs., is about 85 per cent iron and steel, with not more than five per cent other metals. The energy consumption values for producing a pound of the various metals from primary and secondary sources include the energy required for mining and beneficiation of ores, primary smelting, refining, and primary fabrication. In addition to the metals, the energy required to produce such materials as glass, rubber, and plastics, and the energy required for fabrication, machining, assembling and shipping are also considered.

In total, we estimate that it requires about 100 million B.t.u. to produce an average automobile from primary metals. On the basis of an average 8.2 million new U.S. cars produced per year during 1965-70, 100 million B.t.u. translates to a total energy requirement of 0.82×10^{15} B.t.u. — 1.2 per cent of total U.S. energy consumption in 1970.

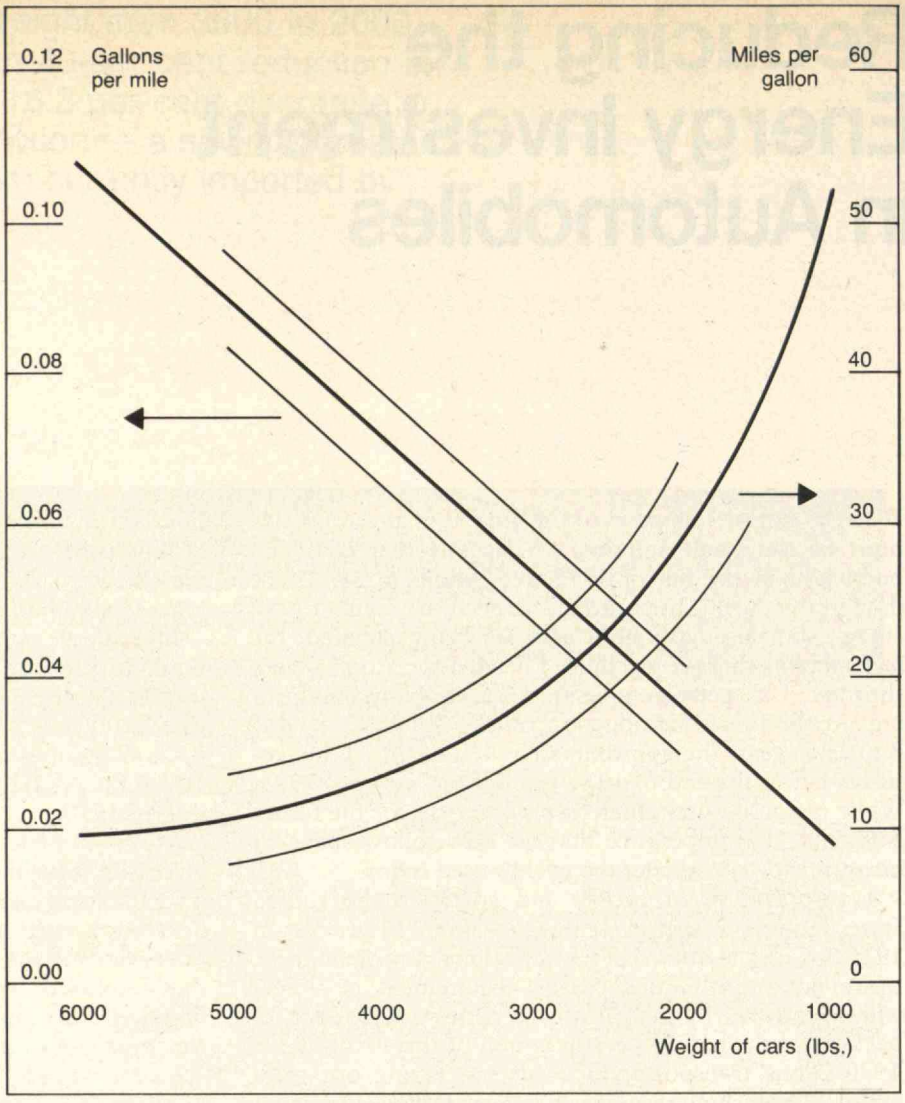
Lower unit energy values for metals can be achieved by increased recycling of scrap. Therefore, one way to reduce the energy consumption in car manufacturing would be to encourage such recycling. As our plight with respect to energy and material resources deepens, we can expect that increased scrap recycling and other energy-saving practices will result in lowering of the unit energy values for some metals (particularly iron, steel, and aluminum). Thus there exists the likelihood that the 100 million B.t.u. figure per car manufactured can be reduced somewhat by improved recycling and improved technology.

A lower limit for car production energy, based on the values for the production of recycled metals, is estimated to be 63.1 million B.t.u. In comparing the highest and lowest car production energy estimates, we conclude that there can be a maximum of 40 per cent savings in current car production energy if recycled metals are used instead of primary metals. With respect to the national picture this savings translates, for example, to a net savings of 0.45 per cent of the total U.S. energy consumption of 1970.

Energy to Fuel

Whereas the energy to produce cars was estimated above to be between one and 1.5 per cent of U.S. annual energy consumption, that required to operate cars is nearly an order of magnitude more. For example, in 1970 the total energy consumed by moving cars was estimated to be about 10.79×10^{15} B.t.u., or 15.6 per cent of total U.S. energy consumption for that year.

The fuel consumption for cars increased by 59 per cent between 1960 and 1970. This increase is due to the compounding effect of 53 per cent increase in miles travelled and four per cent decline in energy or fuel efficiency — miles per gallon or miles per B.t.u. A car's fuel efficiency depends basically on two factors: the specific efficiency of the engine and the weight of the car. A substantial growth in the number of automobiles and particularly in the



The weight of the car and the gasoline consumption or gasoline efficiency of that car are directly related. Sixty different cars weighing from 1600 to 5100 lbs. were tested for their gasoline consumption over a 300- 340-mile course representing typical driving conditions, with the above results.

number of miles travelled is due to changing population patterns (movement to the suburbs) and increasing incomes. Installation of power equipment, particularly air-conditioners, and tendency to buy bigger, heavier cars in the 1960s, have contributed to the decline of fuel efficiency. In addition, according to a recent study, the fuel efficiency of U.S. produced cars has decreased almost 20 per cent just in the three-year period from 1970 to 1973. This decrease reflects the demands of emissions control and safety.

Emissions control measures have thus far involved "detuning" the engine to operate essentially in a low compression mode, which happens to be energy intensive. This situation can be improved either by changing future government emissions regulations, so as to prevent adverse effects on energy consumption, or by technological advances in engine combustion design, or both. For example, adoption of the stratified charge combustion system by U.S. automobile manufacturers can reduce emissions, while minimizing if not eliminating adverse effects on fuel efficiency.

Catalytic converters, presently used to control emissions, are not regarded as a good long term solution, even though they improve gasoline mileage. They are resources (platinum) depleting, and their effectiveness absolutely depends on the use of unleaded gasoline — they are poisoned by leaded gasoline. Two tankfuls of leaded gasoline render them completely ineffective.

The enhancement of the crashworthiness of cars, which is no doubt a much needed measure to decrease the tremendously high highway death and injury tolls (56,000 dead and 2,000,000 injured in 1970), has resulted in reduced fuel efficiency through increasing car weights. An extreme example is the proposed Experimental Safety Vehicles which weigh 5000 lbs. and more. However, crashworthiness is not necessarily dependent on increasing vehicle weight. It depends on the relative weights of colliding vehicles. Hence, safety can be achieved in small cars, if all cars on the road are of the same weight class. Obviously the fuel efficiency of small cars is higher.

For 60 different cars weighing from 1600 to 5100 lbs., the mileage values are directly proportional to car weight, being equivalent to about 1.75×10^{-5} gallons for every pound of car moved one mile. The weight effect of cars on gasoline consumption or gasoline efficiency is empirically demonstrated in the chart above, as plotted from data of the past three years given in *Consumer Reports*. The cars were tested over a 300- 340-mile course representing typical driving conditions.

Energy savings and, more importantly, petroleum savings can, of course, be achieved by increasing the fuel efficiency of the car. Fuel efficiency can be increased both

Source	Energy requirements: (millions of B.t.u.s)	Weight (lbs.)	Per cent of total car	Energy requirements using recycled metals (millions of B.t.u.s)
Mining and processing:				
Steel	47.40	2550	71.00	24.00
Cast iron	4.10	520	14.40	
Aluminum	6.25	50	1.35	.30
Copper	1.55	30	0.85	.22
Zinc	2.10	55	1.50	.30
Lead	0.30	20	0.55	.08
Other materials: Glass, rubber, plastics, etc.	3.30	375	10.35	3.30
Fabrication, machining, and assembling:	31.90			31.90
Shipping:	3.00			3.00
Totals	**99.90 B.t.u.**	**3600 lbs.**	**100.00 per cent**	**63.10 B.t.u.**

Almost 100 B.t.u. are required to produce the typical 3600 lb. American car. If the same car used only recycled metals in production, a maximum savings of over a third of the original total B.t.u. would be realized. It is probable that, as conservation of materials as well as conservation of energy becomes a primary motivation of industry, improved recycling technology and energy-saving practices will lower the energy required to produce recycled iron, steel, and aluminum.

by modifying the car's emission control system and by reducing the car's weight. It is the latter method with which we shall be concerned.

Reducing the Car's Energy Requirements

It stands to reason that in spite of today's inefficient engines, significant savings in energy are possible if the weights of cars are reduced. Weight reductions can be accomplished either by producing smaller cars with the same relative materials composition as that of today's cars, or by producing lighter cars through the replacement of steel and iron by such light but strong metals as aluminum or aluminum-base alloys. The latter alternative would allow car sizes to remain essentially as they are now.

In assessing energy savings due to the production of smaller or lighter cars, we calculate the energy difference between producing cars of that type and that for producing the current typical 3600 lb. cars. This difference is then converted to per cent of total U.S. energy consumption by using the 1965-1970 average figure of 8.2 million cars produced annually and the 1970 total U.S. energy consumption figure of 68.81×10^{15} B.t.u.

The values for energies to produce the various metals, and the energy required for fabrication, machining and assembling have been reduced linearly with the car's weight in calculating the energy required to produce smaller steel cars. In the case of lighter aluminum cars, the energy required for fabrication, machining and assembling is the same as that required for a typical car; the substitution of iron and steel by aluminum, especially on an equal gauge basis, results in the same volume of material to be fabricated, machined and assembled. The shipping energy changes due to car weight reduction are difficult to assess. We have, therefore, allowed shipping energy to be a constant. For both smaller steel and lighter aluminum cars, the energy calculations will be based on primary as well as recycled metals.

In calculating operating or gasoline energy savings, we make use of the empirical relationship between weight and fuel efficiency. Obviously, operating energy savings are independent of whether we are considering steel cars or aluminum cars, primary metals or recycled metals.

Energy Savings Through Smaller "Steel" Cars

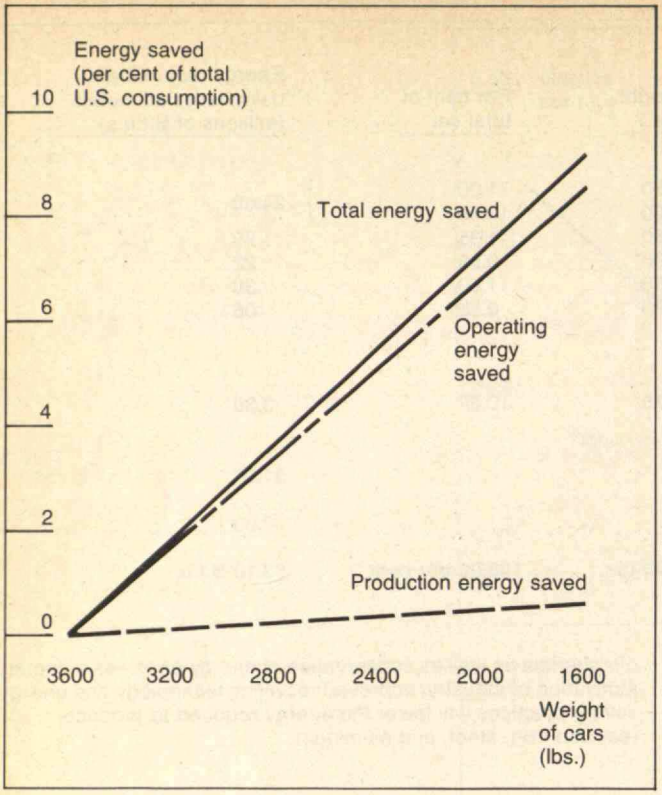
We have plotted the production energy savings, based on primary metals as the materials source, the operating energy savings, and the cumulative or total U.S. energy savings separately, as cars are reduced in weight from 3600 lbs., maintaining the original materials composition (see the top chart on the next page). As to be expected, both production energy and operating energy savings increase linearly with decreasing car weight, since both quantities are directly proportional to weight.

The operating energy saved per pound of car weight reduction is much higher than the production energy saved. For example, if the average car's weight is reduced from 3600 lbs. to 2000 lbs. — that is, if all of us were to drive sub-compacts — a production energy savings of 0.55 per cent, an operating energy savings of 6.95 per cent, and a total national energy savings of 7.5 per cent would result in the United States. This is, of course, a very significant reduction in total U.S. energy requirements.

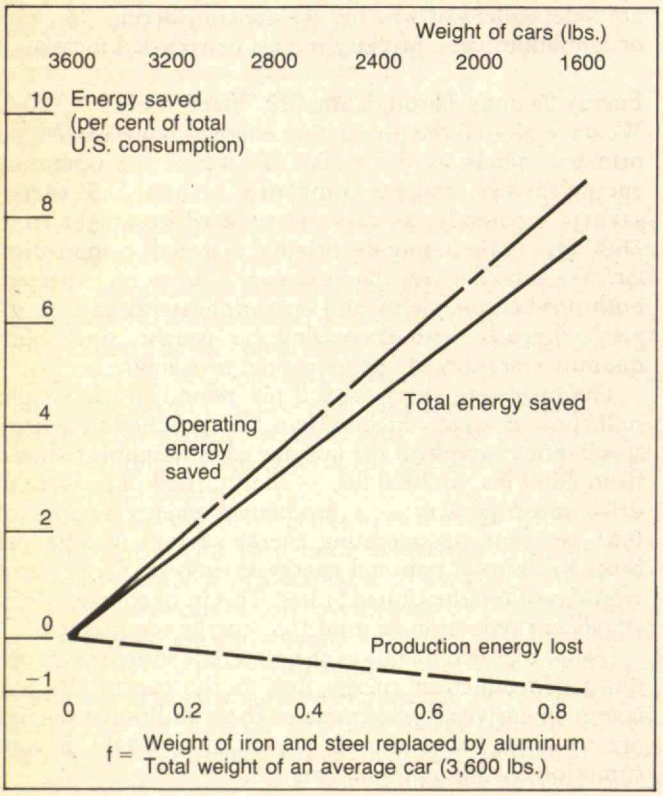
Use of recycled metals as the materials source saves additional production energy due to the use of the less energy intensive recycled metals. These additional savings are not large, being about 0.30 per cent of total U.S. consumption for the 2000 lb. cars.

Energy Savings Through Lighter "Aluminum" Cars

In producing lighter aluminum cars through the use of primary aluminum, an energy penalty must be paid. The energy required to produce aluminum is about 6.7 times that required to produce steel on an equal weight basis.



Savings in production energy, operating energy, and total energy, shown as percentage of total U.S. energy consumption, increase as cars are reduced in weight from 3600 lbs., maintaining their original materials composition. Both production energy and operating energy savings increase linearly with decreasing car weight, since both quantities are directly proportional to weight.



Production energy losses, operating energy, and total energy savings as cars are reduced in weight by replacing steel and iron by primary aluminum on an equal gauge basis, shown as percentage of total U.S. energy consumption, indicate a smaller energy savings than those from the model using reduced amounts of the automobile's original materials.

On an equal volume or equal gauge basis, steel being 2.95 times heavier than aluminum, primary aluminum is 2.27 times more energy intensive than primary steel. Accordingly, if the weight of the car is reduced by substituting its iron and steel with aluminum or aluminum-base alloys, a penalty in energy will result.

We have plotted the production energy losses as steel and iron is replaced by primary aluminum on an equal gauge basis. These losses are relatively significant, being about 0.75 per cent of total U.S. energy consumption for the cars weighing 2000 lbs., or when two-thirds of the steel and iron in the car is replaced by aluminum on an equal volume basis. This means, of course, that one can expect a greater total U.S. energy savings from smaller primary steel cars than from aluminum cars — savings of 7.5 per cent for steel cars as compared with 6.2 per cent for aluminum cars.

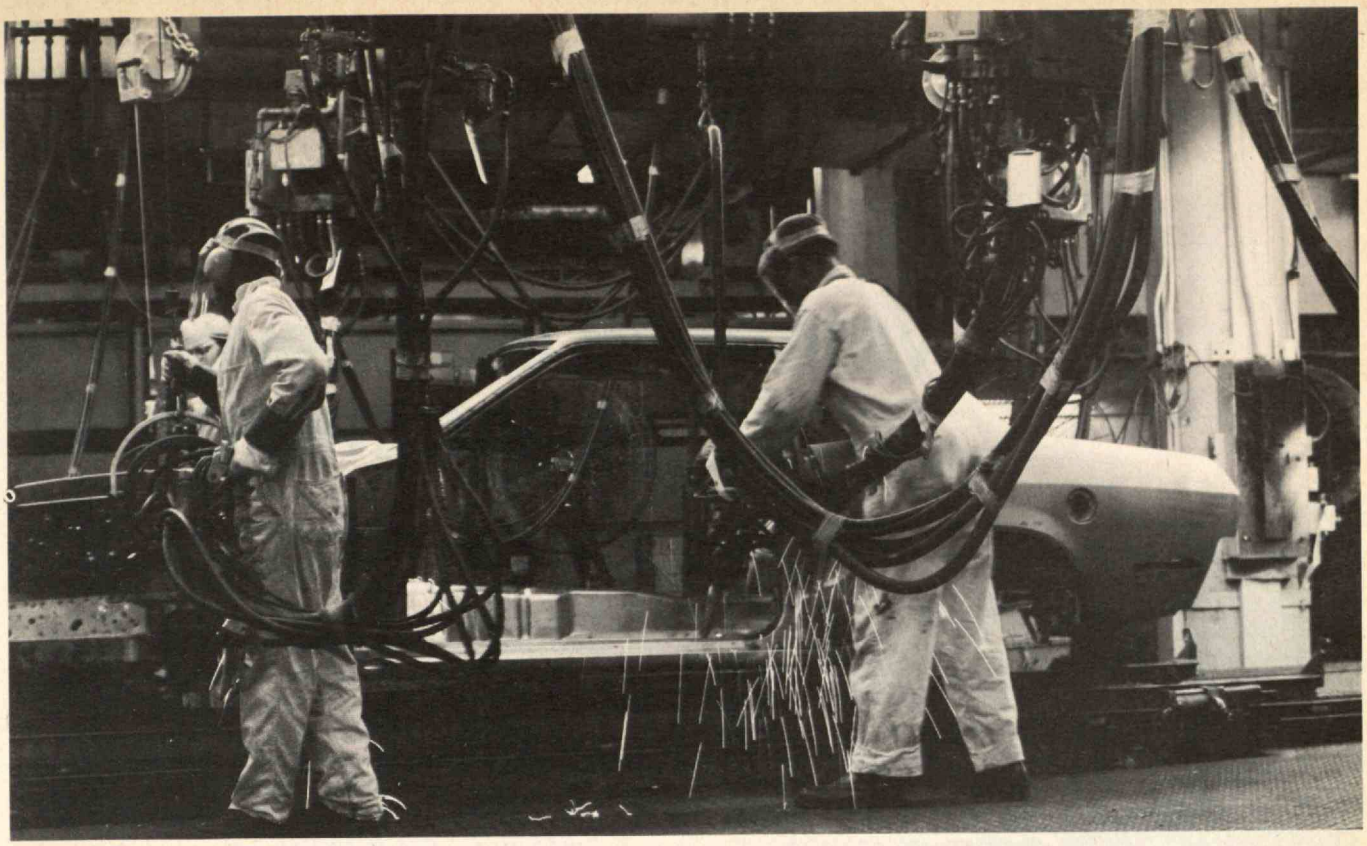
Whereas the energy savings in going from primary steel cars to recycled steel cars are marginal, the relative savings in going from primary aluminum cars to recycled aluminum cars are significant: 1.1 per cent of the total U.S. energy consumption. This is a consequence of the order-of-magnitude difference in the energy required to produce primary and recycled aluminum — there is no energy penalty in using recycled aluminum. The decrease in production energy saved as car weight decreases with the use of secondary materials is a consequence of a small difference between the energy required to produce recycled steel and recycled aluminum in comparison with the difference between the energy required to produce primary and recycled steel.

Automotive Weight Watchers

It is clear that significant energy savings can result if the average car weight is reduced. The most effective means of reducing car production energy is by producing smaller cars with the same materials composition as that of current cars. Use of the less energy intensive recycled steels has only marginal effect on production energy savings. However, recycling of metals is important in extending our decreasing mineral supplies. It is interesting to note that car weights can be reduced, without significant changes in car size, by replacing the currently used low strength steels by higher strength steels. This is applicable, of course, only to car components whose design criterion is strength and not elastic stiffness.

Car weight reduction through substituting the primary steel and iron in the current cars by primary aluminum, on an equal gauge basis, results in a sizable energy penalty. Car production energy savings will result if recycled aluminum is used, but these savings are not as high as those for producing smaller steel cars. Furthermore, the replacing of steel or iron by aluminum on an equal gauge basis is not feasible for car components designed on elastic modulus — those which require elastic stiffness. In these cases, the replacement must be made on an equal weight basis because the specific elastic modulus (elastic modulus/density) of aluminum or aluminum-base alloys is the same as that of steel and iron, resulting in no weight reduction and no energy savings.

Clearly the most significant energy savings resulting from the reduction in the average car's weight from 3600 lbs. to 2000 lbs. is the operating or gasoline energy savings. Independent of the means of car weight reduction, about seven per cent reduction in U.S. energy requirements could result if the average car weighed 2000 lbs.



Even as it comes off the assembly line, the average 3600 lb. automobile has already used 97.90 million B.t.u., almost a third of which go into fabrication, machining, and assembly. Although a production savings of only 0.55 per cent of the total U.S. energy requirement would result from limiting automobile weights to 2000 lbs., the operating energy savings would be a significant 7.5 per cent. (Photo: Ford Motor Co.)

This seven per cent reduction in operating energy is an order of magnitude greater than the largest possible car production energy savings — those resulting from building 2000 lb. cars from recycled steels. Therefore, the highest total energy savings would result from our driving four-passenger sub-compacts instead of six-passenger sedans. Smaller cars should not create undue discomfort to the average family on the average trip, since the average number of occupants per car in the U.S. is about 1.8.

The automobile operation or energy savings will, of course, have a positive impact on the petroleum shortage. The seven per cent reduction in U.S. energy consumption translates to 16.3 per cent of the nation's petroleum energy demands, or, very significantly, 41.8 per cent of the nation's gasoline demands, based on 1970 figures. The 16.3 per cent of decrease in petroleum energy requirements can mean that, if need be, we can do without the petroleum imports from the Middle East, which in 1972 accounted for about eight per cent of our petroleum energy requirements. This magnitude of savings can also mean a significant alleviation of the current refining capacity problems. It is interesting to note that if all cars are of the 2000 lb. weight class by 1980, the petroleum reserves of this nation will last an additional five years, that is until 1998, instead of the current projected year of 1993. These extra years may be needed for the technological development of alternate power plants and synthetic fuels for the transportation needs of the next century.

In this study we have considered only the introduction of lighter cars as a means of car energy conservation. There are other conservation measures of different natures, and each should be given serious consideration in light of personal transportation needs and desires. Transportation, as such a large consumer of the nation's petroleum energy and total energy, does indeed offer great possibilities for energy conservation. Conservation of energy and all resources is good long range planning in any society at any time; in our society it is crucial now.

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Automobile fuel economy can be improved considerably using technology available today. But government regulation may be needed to do it.

Photo by Robert J. Izzo

Charles E. Cohn
Argonne National Laboratory

Improved Fuel Economy for Automobiles

Improving the fuel economy of the automobile is an important factor in dealing with the energy crisis. This has commonly been discussed solely in terms of exhorting consumers to choose smaller cars, as it is generally believed that the conventional internal-combustion automobile as currently manufactured has reached its limit of attainable fuel economy for a given level of pollution control. On the contrary, there are many measures, as will be described below, that offer potential for improving the fuel economy of all sizes of cars. Spectacular improvements may not necessarily be obtained from any one measure, but the total effect of a variety of measures could certainly yield a worthwhile gain.

None of these measures is based on an extrapolation of technology; all are realizable under the present state of the art. Some of the measures would increase the price of the automobile, but such increases should become more justifiable as fuel becomes more scarce. The average "full-size" car consumes over $5,000 worth of gasoline at present prices during a 100,000-mile lifetime, so even modest gains would yield significant cost savings for the owner.

A considerable amount of gasoline could be saved by selecting smaller cars, but the real technological challenge is to improve the basic efficiency of the mechanism. I believe that we can realistically expect large cars to have acceptable fuel economy and could continue to enjoy the safety and comfort advantages of large cars.

Some writers have looked at the thermal efficiencies of present internal-combustion engines and have concluded that little improvement is possible. That is a mistaken view. Recall that the ideal automobile would be completely frictionless and thus would consume no energy at steady speed on a level road. Furthermore, energy consumed in acceleration or hill-climbing would be fully recovered on braking or descent. Thus, the ideal automobile would consume no net energy. The approachability of that ideal is evidenced by the economy figures of up to 377 m.p.g. attained in trials such as the Shell Mileage Marathon. The potential for fuel-economy improvement is therefore almost unlimited.

The Engine — Varying the Compression Ratio

The basic thermal efficiency of an internal-combustion engine is determined by the compression ratio. In a spark-ignition engine, the ratio is normally set as high as is allowed by the antiknock value of the available fuel. The limiting condition normally occurs at full throttle and low speed. An automobile engine runs almost always at part throttle and, hence, with a compression ratio and thermal efficiency lower than need be.

To overcome this, a number of variable-compression schemes have been proposed. A successful embodiment, disclosed in 1952 by W. H. Paul of Oregon State College and I. B. Humphreys of Humphreys Investment Company, consisted of an L-head or side-valve configuration with an auxiliary piston in the cylinder head as shown in the drawing on page 46. At full load, this auxiliary piston was fully retracted upward, giving the minimum compression ratio. At light loads, the auxiliary piston extended downward, reducing the volume of the combustion chamber and so increasing the compression ratio. The scheme employed hydraulic control of the auxiliary pistons in response to compression pressure to vary compression ratio between 6.5 and 14. Fuel economy gains of 50 per cent were attained.

Not all of this gain arises from increased thermal efficiency. Some of it comes from more favorable fuel-air mixtures. At idle or light load, up to one-third of the charge in the cylinder is made up of exhaust gas from the previous cycle left in the combustion chamber. The presence of this inert component makes excessively rich mixtures necessary to insure ignitability. Increased light-load compression ratio and consequent reduced combustion-chamber volume decreases the exhaust-gas carry-over and permits leaner mixtures. The embodiment mentioned above raises the optimum steady-speed air-fuel ratio from 15.0 to 19.5. Besides improving economy, the ability to burn such lean mixtures facilitates the control of all pollutants.

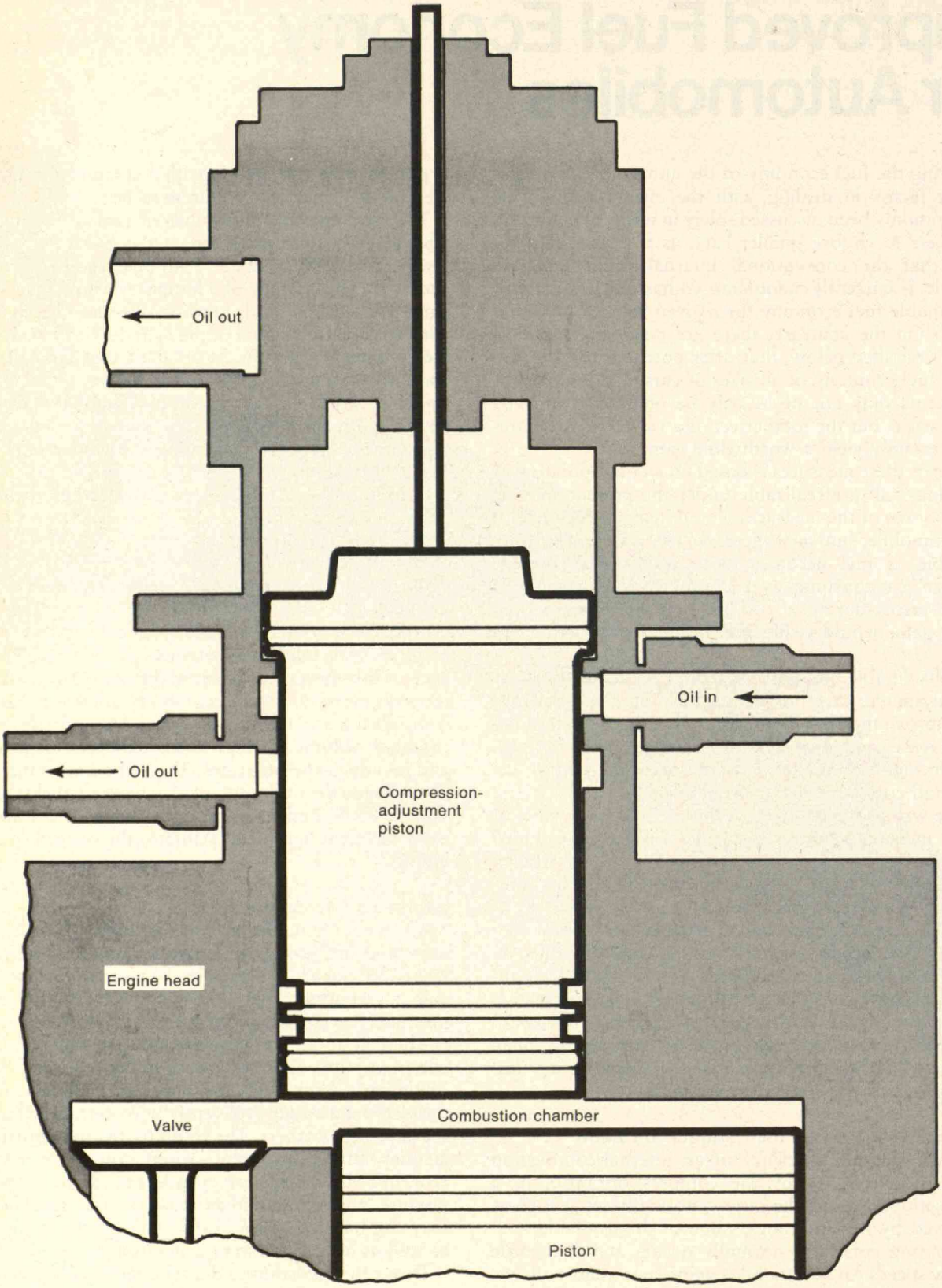
Improving Carburetion

Laymen commonly believe the carburetor to be the key to improved fuel economy. However, fuel mixture requirements are normally determined by other considerations, and a carburetor that accurately delivers the required mixtures leaves little room for improvement.

There is room for improvement, though, in the distribution of the fuel-air mixture to the cylinders. Where a single carburetor feeds a number of cylinders, the fuel droplets tend to go preferentially to certain cylinders at the expense of others. The resulting relative spread in the air-fuel ratio going to the various cylinders is 10-15 per cent. In order for the lean cylinders to receive an ignitable mixture, the rich cylinders must receive more fuel than they can burn most efficiently. This results in fuel waste as well as added pollutant generation.

Direct fuel injection to the cylinders would equalize the

Varying the engine compression ratio can increase mileage up to 50 per cent. The mechanism diagrammed below for varying the compression ratio consists of an auxiliary piston in the cylinder head. At heavy loads, when decreased compression ratio is required, the piston is retracted upward increasing combustion chamber volume. At light loads, the piston extends downward, reducing combustion chamber volume and increasing compression ratio. Proposed in 1952 by W. H. Paul of Oregon State College and I. B. Humphreys of Humphreys Investment Co. (Courtesy of the Society of Automotive Engineers.)



fuel distribution, but is expensive, costing at present several hundred dollars. A more economic possibility is the introduction of ultrasonic energy to the intake manifold to obtain finer atomization of the fuel. Some work has been done with an ultrasonic transducer in the intake tract, driven by an electronic oscillator.

It might be more reasonable to use an ultrasonic whistle driven by manifold vacuum. This has been promoted as a retrofit anti-pollution device by the Echlin Manufacturing Company of Branford, Connecticut, but its full potential for improving fuel economy has not been explored.

Fuel economy gains of three to four per cent have been obtained with high-surface-energy gasoline additives that prevent liquid gasoline from wetting the walls of the intake manifold, by A. A. Zimmerman, L. E. Furlong and H. F. Shannon of the Esso Research and Engineering Company. This reduces the spread in air-fuel ratio between cylinders by a factor of two. The additives consisted of either nonpolymeric amines or dimethyl silicones. A similar result could be obtained from a fluorocarbon lining for the manifold of the type used on Teflon-coated frying pans.

The Siemens organization in Germany has been working on a carburetor in which the gasoline is catalytically converted to a gaseous fuel, which would burn more efficiently than gasoline droplets.

A source of inefficiency now affecting all spark-ignition engines is cyclic dispersion. This is the variation in the amount of power produced by individual explosions, and has been attributed to random inhomogeneities in the mixture that affect the processes of flame initiation and propagation. Economy gains up to 10 per cent would be possible if all explosions were as effective as the best ones, and smoother running would be obtained. The measures discussed in this and the preceding subsection should assist in reducing cyclic dispersion.

The carburetor, intake manifold and valve timing of current engines are designed to optimize power at unusably high car speeds of 100 m.p.h. and above. As a result, these components are suboptimal in the economy range around 50 m.p.h. Economy gains should result from optimization for the normal driving range at the expense of high-speed performance. Also, combustion chamber configurations have been optimized for full-throttle operation and are suboptimal for the combustion of lean mixtures in normal driving.

Furthermore, the stylists' demand for low engine height may well hamper optimal design of the carburetor and manifold. That constraint, for one, precludes the use of a riser or mixing length between the carburetor and the manifold branches for improved mixture distribution.

A Better Explosion

The ignition system does not show much potential as a source of economy improvements. In general, enhancement of the spark beyond the minimum needed for ignition, such as by electronic ignition systems, does not seem to yield much benefit beyond allowing for larger plug gaps and giving more reliable sparking in the presence of plug fouling. T. Tanuma, K. Sasaki, T. Kaneko and H. Kawasaki of the Nissan Motor Company have found that increases in plug gap up to 1.5 mm. improve the ignition of lean mixtures. The provision of two spark plugs per cylinder has been found to reduce cyclic dispersion and aid in the ignition of lean mixtures. Teledyne Continental Motors has brought out an industrial engine having two spark plugs per cylinder that fire at different times in the cycle. Fuel economy improvements of 15-22 per cent are claimed. A multiplicity of sparks per cycle has been suggested by the Texaco Research Center in Beacon, New York and the Autotronic Controls Corporation of El Paso, Texas, as another aid to the ignition of marginal mixtures.

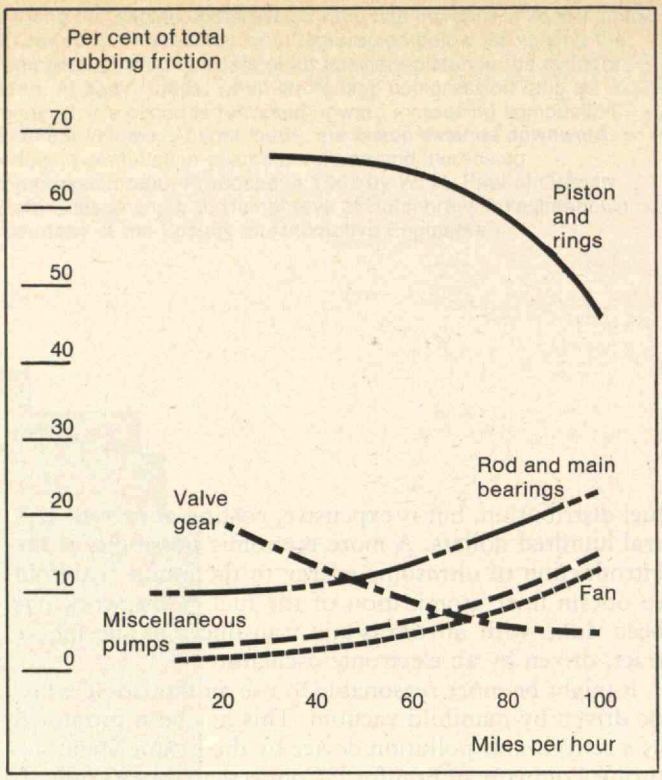
Internal Friction

At steady speed, a significant portion of the mechanical energy produced by the engine is used up in overcoming its own mechanical friction. This amounts to a loss of about one-seventh in a 144 cubic-inch (small) engine.

For cars with more power, the relative portion of loss increases approximately in proportion to the power-to-weight ratio. This friction is the source of "engine braking" — a brake that is on all the time. The major part of the friction arises from the pistons and rings, as shown in the graph on page 48.

The magnitude of the friction is strongly dependent on bearing and piston clearances and ring pressures. However, these parameters are normally designed on the basis of considerations other than friction. Piston-to-cylinder clearances are set for quiet operation in a cold engine, ring pressures are set to minimize oil consumption, while crankshaft bearing clearances are set to control oil throw-off onto the cylinder walls. In racing engines, where maximum power is of prime importance, clearances are set much looser than in passenger-car engines, resulting in about 20 per cent less friction.

An authoritative textbook by Professor C. Fayette



Friction losses in an automobile engine are due to pistons and rings, rod and main bearings, pumps, the fan, and valve gear. This graph shows the relative losses at different speeds for a 144 cubic-inch-displacement engine. (Courtesy of the Society of Automotive Engineers.)

Taylor of M.I.T. recommends journal-bearing clearances of .001 to .002 times journal diameter, but present car engines use as little as one-tenth of that. Why?

Could looser clearances and ring pressures significantly improve fuel economy without compromising durability? This might increase lubricating oil consumption through greater oil throw-off from the bearings and passage by the rings. However, the former could presumably be controlled by suitable baffles in the crankcase or by regulating orifices in the oil passages. In any case, the oil consumption of contemporary engines is much less than the one quart per 1000 miles that was considered normal 20 years ago. Has this reduced oil consumption been bought at the price of increased friction?

Racing-engine builders also find it worthwhile to remachine the parts of production engines in order to refine such critical areas as crankshaft bearing and journal alignment. Do production tolerances give rise to significantly increased friction due to misalignment?

Could some or all of the piston rings be made with facings of graphite or other non-metallic self-lubricating material? This might reduce friction particularly at the ends of the stroke where the piston reverses direction and hydrodynamic lubrication momentarily breaks down. Also, self-lubricating inserts where the bottom of the piston rubs on the cylinder walls might produce the needed piston stabilization with less friction than the skirt contact relied upon at present. Ring and skirt temperatures are under 450 and 300 degrees F. respectively, which suitable materials of this type can withstand.

Pumping Losses

In all part-load operation, energy is lost in the process of sucking the intake air through the carburetor past the partially-closed throttle. At steady speed, this loss is comparable in magnitude to the friction losses. Measures allowing combustion of leaner mixtures, including the various stratified-charge schemes as well as those discussed above, reduce these losses by increasing the volume of air inducted and so decreasing the pressure drop across the throttle.

These losses could be recovered by an arrangement similar to a supercharger, in which a positive-displacement blower is placed ahead of the intake manifold. However, unlike a supercharger, the gearing would be such that the blower would have a smaller displacement than the engine, yielding the manifold pressures below atmospheric that are characteristic of part-throttle operation. In the process, the blower would transfer power to the engine by making the intake air do work in the process of undergoing a pressure drop. Manifold pressure, and hence engine power, would be regulated by a variable gear ratio between engine and blower.

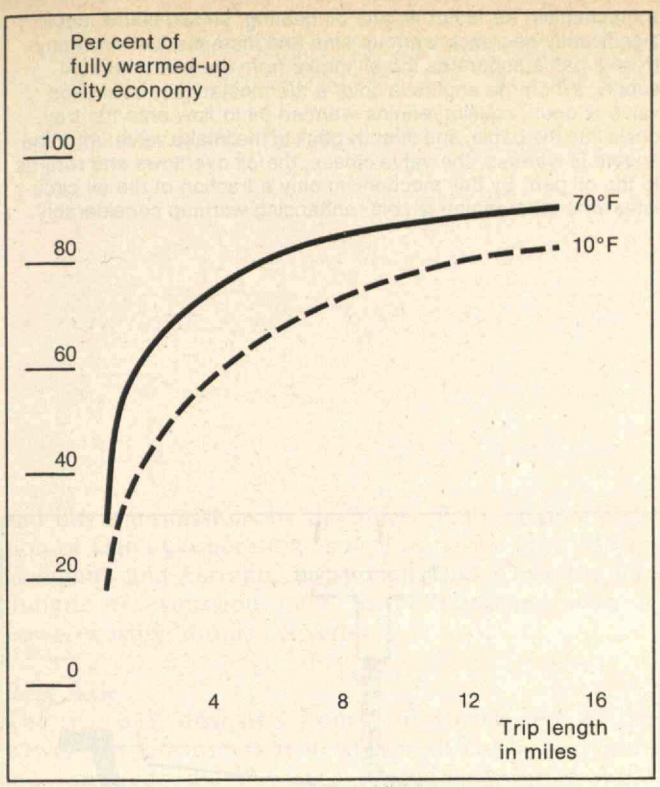
If this approach were not cost-effective, some of the losses could instead be recovered by making greater use of manifold vacuum to drive accessories. (This is "free" power because, again, the intake air might as well be made to do work in the process of undergoing a pressure drop.) Such increased utilization would require a carburetion system that could maintain correct mixture even if a significant fraction of the intake air did not come through the carburetor.

Faster Warmup

There is considerable room for improvement in the warmup process. C. E. Scheffler and G. W. Niepoth of General Motors have found that in the first mile of a winter drive, an average car gets only 25 per cent of its fully-warmed-up economy, and only 85 per cent of the latter is realized on a winter trip as long as 16 miles, as shown on the facing page.

Since most auto trips are short, faster warmup should yield significant fuel savings. Warmup of today's cars is slower than need be because modern engines have been designed to minimize the portion of waste heat going to the coolant. Such design reduces the cost of the radiator and allows grille styling that restricts air flow.

The portion of waste heat emitted in the exhaust is about equal to the portion removed by the coolant. Therefore, warmup could be speeded by up to a factor of two if the exhaust heat could be transferred to the coolant. One might envision a heat exchanger between the



Warmup in today's engines is slow, reducing efficiency. In the first mile of a winter drive, the average car gets only 25 per cent of its fully-warmed-up economy. (Courtesy of the Society of Automotive Engineers.)

exhaust gas and the cooling water that operates only during the warmup period. A thermostatic valve could divert the exhaust away from the heat exchanger when warmup is complete. Also, suitable insulation might help keep the engine warm while the car is parked for short periods.

Engineers knew 40 years ago that a heat exchanger between the cooling water and the engine oil greatly speeds warmup of the latter. Also conceivable would be an arrangement analogous to the "hopper tank" used on reciprocating aircraft engines, in which a baffle isolates the oil intake and return from the bulk of the oil supply so that just a fraction of the oil in the pan is circulated during warmup. (See diagram on p. 50.)

Most automatic transmissions are equipped with a heat exchanger between the transmission oil and the cooling water that is supposed to perform a warmup as well as a cooling function. However, its warmup effectiveness is limited because it is placed on the cold side of the radiator, which is the coolest part of the system. The water temperature there is much lower than the 200 degrees F. considered the desirable lower limit of transmission-oil temperature. Moreover, it is not effective until the engine warms up enough to open the thermostat. A heat exchanger in a bypass circuit would be much better. Even a bypass connection from the cylinder head to the cold-side tank might help.

Eliminating Idling

Idling is the least desirable of all operating modes. Besides being totally wasteful of fuel because no useful work is being done, it promotes engine wear and oil contamination and is highly productive of pollution. It has been shown to be economic to shut off the engine for halts longer than 24 seconds, such as at railroad crossings. (A typical V8 engine consumes 0.0125 gallons-per-minute while idling, but uses only 0.005 gallons for a hot restart.) Fuel could be saved and pollution reduced if it could be made practical to shut off the engine automatically when the car comes to a halt, and restart it when the driver depresses the accelerator to go. Systems of this type have been announced for manual-transmission cars by the Toyota Motor Company and by E. Jucker Relaisbau of Zurich, Switzerland, with fuel savings of 10 per cent in city driving. They shut off the ignition when the car has been stopped for 1.5 seconds, and restart the engine when the driver depresses the clutch to put the car back in gear.

Intermittent engine operation has considerable potential for saving fuel. Gains up to a factor of three have been obtained in the Shell Mileage Marathon from regimes of acceleration at full throttle, where the engine is most efficient, alternated with engine-off coasting.

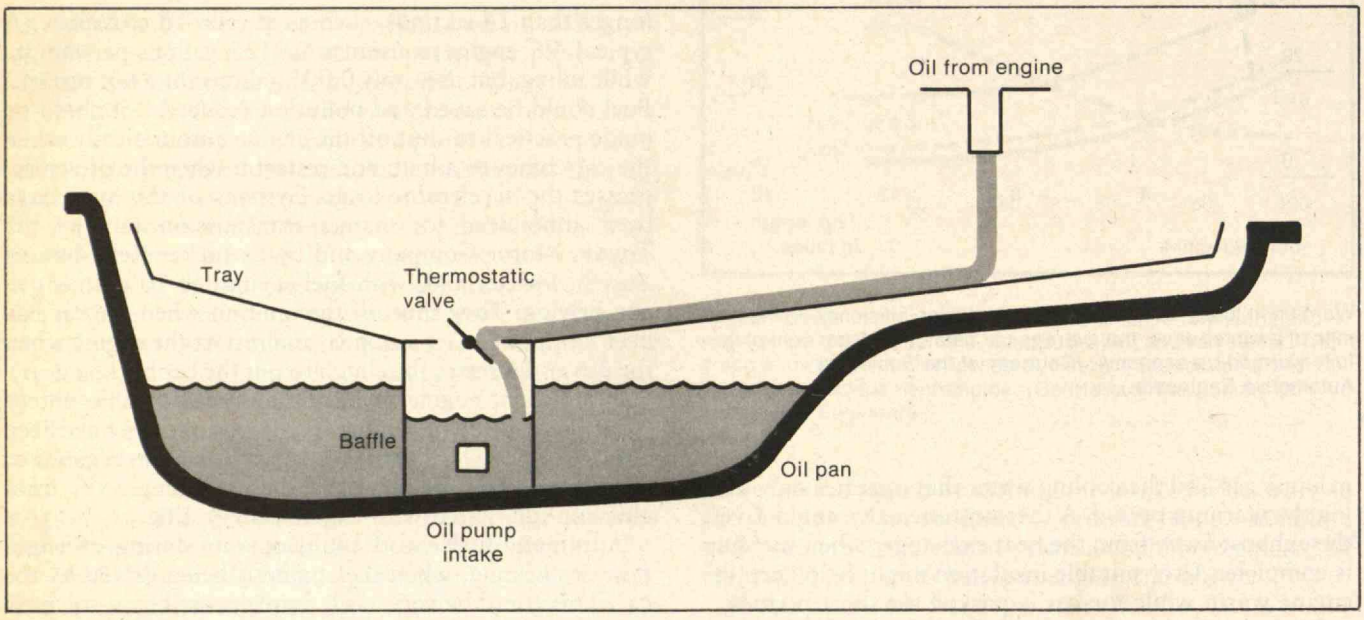
Automatic fuel cutoff could operate during deceleration or coasting, when the engine is being driven by the car. This could be very easily implemented by a solenoid valve in the carburetor idle circuit, arranged to shut whenever the engine turns faster than idle with the throttle closed. This would be especially valuable in mountain driving, where the engine could consume no fuel at all during the long downhill runs. Since the engine would remain in gear, laws against coasting in neutral would not be violated. In fact, with no power produced, engine braking would be enhanced.

Transmissions

The ideal transmission would cause the engine to operate at the lowest possible speed at which it can deliver the needed power. In that way, friction and pumping losses would be held to a minimum. Existing transmissions fall far short of that ideal. In 1952, D. F. Caris and R. A. Richardson of the General Motors Research Laboratories pointed out that a closer approach to the ideal could yield a fuel saving of 25-35 per cent. No such improvement has taken place since then.

For overall efficiency, no existing transmission can beat the good old clutch and manual gearshift. (Its efficiency is over 99 per cent at steady speed.) Overdrive, which was quite popular twenty years ago, provides a closer approach to the ideal transmission and can yield a 15 per cent improvement in fuel economy. Unfortunately, most American drivers have become unwilling or unable to put forth the effort and skill needed to operate the manual transmission and clutch. Furthermore, recent trends in

A mechanism for faster engine oil heating, shown below, could significantly decrease warmup time and increase fuel economy. Here a baffle separates the oil intake from the bulk of the oil supply. When the engine is cold, a thermostatically-controlled valve is open, causing engine-warmed oil to flow onto the tray, down into the baffle, and directly back to the intake valve. After the engine is warmed, the valve closes, the oil overflows and returns to the oil pan. By this mechanism only a fraction of the oil circulates when the engine is cold, enhancing warmup considerably.



auto design have reduced the acceptability of the clutch. An over-center or toggle spring used to be included in the pedal linkage to reduce the force needed to depress the pedal. This has been omitted from most recent models, presumably as a cost-saving measure. Also, the low seating position of today's cars increases the difficulty of operating the pedal. The acceptability of the clutch might be improved through power assist to the pedal, similar to the present power brake.

At steady speed, the conventional automatic transmission wastes seven per cent of the power applied to it. This loss is about equally divided between torque-converter slippage and losses in the gearbox from friction and from the power consumed in pumping oil through the hydraulic control system. Under acceleration the loss increases, to 35 per cent at wide-open throttle, due to increased torque-converter slippage. This inefficiency is partially compensated by the use of smaller rear-axle gear ratios and hence lower engine speeds for a given car speed.

There are a number of possibilities for improvement of automatic-transmission efficiency. An improved torque converter has been developed by Variable Kinetic Drives, Ltd. in England. It incorporates a differential gearing arrangement between input and output elements and an additional variable-pitch turbine element. Variable-displacement pumps that would pump only as much oil as is actually needed to operate the hydraulic control elements could save the power wasted in pumping excess oil through a relief valve. A positive-displacement hydraulic arrangement with mechanical lockup has been proposed by Cummins Sundstrand, Inc. to replace the present hydrodynamic systems. Some early models of automatic transmission had clutches to cut out the torque converter at steady speeds by locking together the input and output shafts, thus eliminating slippage. Use of a flywheel or a hydraulic accumulator has been proposed to absorb the car's kinetic energy on deceleration and release it on subsequent acceleration. Such a flywheel would be spun up to help brake the automobile, releasing its energy upon acceleration to aid the engine.

A particularly fruitful approach might be to combine the virtues of the automatic and manual transmissions. One can envision a manual gearbox and clutch, with the controls actuated not by the driver but by an automatic system. In particular, the clutch release lever, the gearbox shift levers, and the throttle could be actuated by vacuum cylinders controlled by suitable electronics, to which car speed, engine speed, and gas pedal position would be inputs. Modern control technology should provide smoothness of operation superior to that of the best drivers. A similar approach has already been taken for truck

and bus transmissions by the Spicer Transmission Division of Dana Corporation as well as by the Ford Motor Company and Ferranti, Ltd. in England. Does the automatic transmission have to be burdened with a power-wasting torque converter?

Rear Axle

The rear axle dissipates from 5 to 10 per cent of the power that it transmits at steady speed. The hypoid gearing system adopted 40 years ago to allow lowering of the floor has more friction than the older spiral level system because of sliding contact between gear teeth. Therefore, contestants in economy trials find it worthwhile to change over to spiral-bevel gears.

Friction of oil seals is a factor throughout the engine and drive train. To what extent could seal friction reasonably be reduced, even at the cost of a small amount of oil leakage at non-critical points?

Tires

The rolling resistance of tires is highly dependent on their construction. However, tires are normally designed to optimize other qualities, and low rolling resistance has not been emphasized as a design goal (although, presumably, low power consumption would be highly correlated with slow tread wear). At speeds below 60 m.p.h., radial tires can give about 28 per cent less resistance than bias-ply tires, with bias-belted tires being intermediate. For minimizing power consumption at low speeds, the best present combination of materials is steel for the belts with rayon or polyester for the plies. Bald tires have about half the resistance of new ones, and wide tires have less resistance than narrow ones.

A rating of rolling resistance should be included in any scheme for tire grading.

Air Conditioning

Air conditioning adds a significant increment to fuel consumption when it is in operation. Utilization of the "free" thermal energy in the exhaust via absorption refrigeration has been considered and rejected by the auto industry because it appeared that insufficient refrigeration capacity could be derived. However, improvement in absorption-refrigeration technology (which has also been suggested as an energy-conservation stratagem) might well call for re-examination of the technique. In absorption refrigeration, heat is used to drive a dissolved gas from a liquid, creating a pressure. The pressurized gas is allowed to expand, thus cooling, and then is reabsorbed into the liquid, from which it is driven again in a continuing cycle.

Efficiency gains might also be possible in present air-conditioning systems. Temperature control is important in automobile air conditioners because a large excess of cooling capacity is provided for rapid cooldown of a car parked in the sun. In an effort to maximize evenness of control, most factory-installed units use relatively inefficient methods, i.e., hot-water reheat of the cooled air and throttling of the compressor inlet. It would be more efficient to use hot-refrigerant reheat, on-off compressor cycling or a variable-displacement compressor. The cooling load might be reduced by improved body insulation and sunshades for the windows. Power consumption could also be reduced by a variable-ratio belt drive for the compressor (and other belt-driven accessories) with which accessory speed would be relatively constant with respect to engine speed.

Performance and Styling Rationalization

The fuel consumption of an automobile is strongly influenced by the acceleration capability built into it, even when that capability is not being used. That is because a higher-powered car operates in normal driving at a smaller fraction of maximum power, so that friction, pumping, and other losses loom larger. This results in a sacrifice of approximately one m.p.g. for each additional 120 horsepower.

Car buyers commonly select overpowered cars for irrational motives and then attempt to justify their choice by arguing "safety." It would be useful for the highway-safety authorities to determine just how much performance capability is really needed for safe driving. Since the 55 m.p.h. speed limit is likely to be with us indefinitely, it is hard to see the justification for the ample power reserves at much higher speeds that today's cars provide. An engine sized for a maximum cruising speed of 55 m.p.h. could be extremely tiny, offering weight savings on top of improved efficiency. A more favorable trade-off between performance and economy might be possible through a scheme disclosed by W. H. Percival and W. H. Ahrens of the General Motors Research Laboratories in which compressed air is used to supercharge the engine when power demands are high. This can yield a 15 per cent economy improvement by allowing a given level of performance to be obtained with a smaller engine.

A significant amount of energy is consumed in overcoming air resistance. (Air resistance is about equal to rolling resistance at 55 m.p.h. At lower speeds, air resistance decreases relative to rolling resistance as the square of the

speed.) Thus, streamlining has frequently been suggested as a means toward improved fuel economy. Advocates of streamlining, however, do not take into account the weight of the additional structure needed to implement the streamlining. Structurally, the most efficient shape is a box just large enough to provide the needed space. Departures from that shape would necessarily lead to increased weight and hence reduced fuel economy at the rate of 0.1 m.p.h./100 lb. for big cars and 0.4 m.p.g./100 lb. for small cars.

Designers have tried to circumvent that constraint by cutting down on the passenger space they allow, even in the big luxury cars. (As an owner of one such car said, "Why are they so big on the outside and so small on the inside?") The most noticeable shortfall is in height. In today's cars, the seats are so low that the occupants practically sit on the floor, with their legs projecting straight ahead. For a given legroom, these cars have to be longer and hence heavier than the older cars where the seats were higher and the occupants' legs more nearly vertical. Thus, a sacrifice of sleek styling, as well as unneeded performance, might well yield a more favorable trade-off between comfort and economy. How much of our precious resources has been squandered just to turn our automobiles into toy racing cars, symbolic penises, or sculptures on wheels?

In the same vein, how much of the added cost and weight of the new energy-absorbing bumpers can be charged to styling? The spring-steel bumpers used 45 years ago were light and cheap and yet had considerable energy-absorbing capability.

It is worth noting in this context that a stock 1951 Lincoln, weighing 5200 pounds, won that year's Mobilgas Economy Run (on a ton-m.p.g. basis) with better than 25 m.p.g. Today, thanks to 23 years of technological progress, cars of that class claim around 15 m.p.g. in comparable trials.

Implementing Fuel-Saving Technologies

A government-sponsored research program, completely independent of the auto industry, is needed to explore and evaluate the various approaches discussed here. The aim of this program should be to produce and test models of the various devices, culminating in designs that could be made suitable for production by routine engineering.

There is a well-known trade-off between fuel economy and pollution control in automobiles. A 14 per cent increase in fuel consumption over uncontrolled cars has been attributed to the 1973 emission controls. The program would indicate the full dimensions of this trade-off and thus assist in the formulation of realistic and sensible pollution standards.

The automobile manufacturers have, in the past, been extremely reluctant to adopt improved fuel-saving technology especially where it originated outside their own organizations, added significantly to the automobile's initial cost, or diluted its emotional appeal. Therefore, despite our misgivings about extensions of government regulation, government standards might be necessary to assure that the best available technology is actually used in producing automobiles. The most expeditious way that such standards might be applied is through imposition of specifications by the General Services Administration on automobiles for government purchase, as was done in the early stages of the auto-safety effort. The information to be provided by the research program would be important in setting such standards.

It is quite likely that the program would yield devices suitable for retrofit to existing automobiles. Such devices should find ready public acceptance. Gadgets for improving fuel economy have found a ready market ever since the early days of the automobile, even though most have been technically unsound and ineffective.

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Charles Erwin Cohn holds A.B., M.S., and Ph.D. degrees in physics from the University of Chicago. He is a physicist in the Applied Physics Division, Argonne National Laboratory, with which he has been affiliated since 1956. He has done work on noise analysis in nuclear reactors and on the application of computers to nuclear-reactor experiments. He is a member of Phi Beta Kappa, Sigma Xi, the American Physical Society and American Nuclear Society.

Dr. Cohn's interest in fuel economy is extracurricular. "I am one of those oddball cheapskates who was concerned about fuel economy even before the energy crisis," he says. "Now that the public shares my concern, I felt it was an opportune time to communicate what I have learned in this area."

Photo by Robert J. Izzo

The Car in Your Future — What the Studies Say

Reconciliation may be difficult, but we must relearn to live with our old friend the automobile despite the problems it has caused us. The automobile will be the staple transportation mode in the U.S. for a long time to come, according to Claude S. Brinegar, former Secretary of Transportation. Private automobiles will continue to move 80 to 85 per cent of the people in cities, leaving only 15 to 20 per cent for mass transit, he said in a recent speech to the Society of Automotive Engineers.

Successful reconciliation with the automobile depends on adjustment to short rations — economic and technological measures to reduce U.S. gasoline consumption to match expected supplies. Recently released government studies have been solving the whats and hows of such measures:

— Rand Corporation researchers, echoing many other government experts, contend that the only way to reduce gasoline consumption significantly within the next four years is by increasing its price. Using an econometric model, they estimate that taxes of 15, 30, and 45 cents per gallon would mean annual gasoline savings of 16, 34, and 40 per cent, respectively, by 1980. Such a tax increase would result in fewer people owning cars, less driving, and a definite — though not severe — down-turn in auto industry employment.

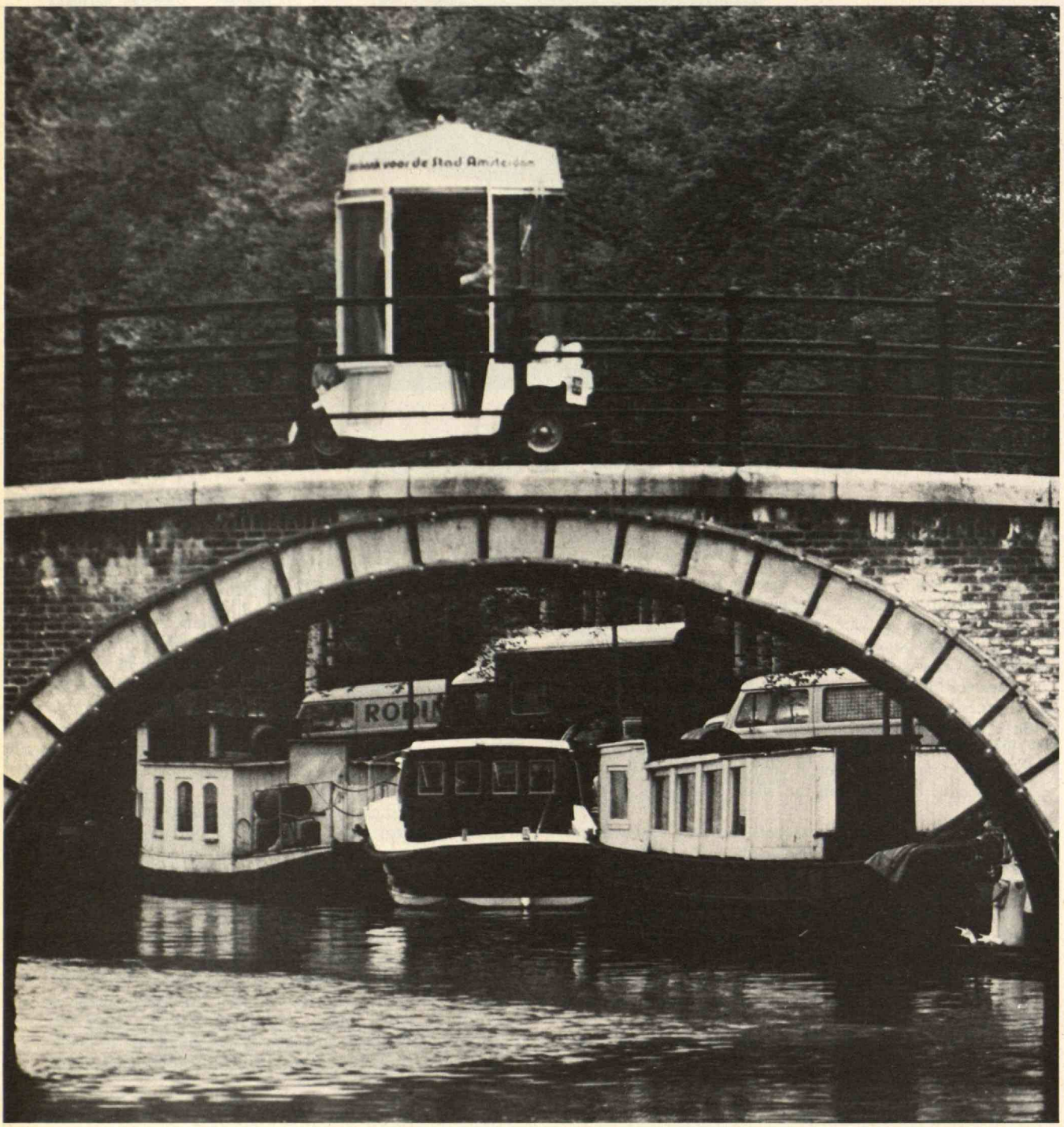
The Rand Corporation researchers by no means ruled out improvements in the automobile itself, but said that changes implemented after 1975 would save only about 10 per cent in gasoline by 1980 because of the remaining high-fuel-using cars on the road.

— Gasoline savings possibilities through technological improvement — much less jarring to our daily lives — run from 40 to 60 per cent. A joint study by the Department of Transportation and the Environmental Protection Agency found that a 40 per cent improvement in mileage — an increase from 14 to 20 miles per gallon in the next five years — would save more than a million barrels of oil per day in 1980. Technological changes required would be improvements in the efficiency of engine and drive train, an engine size reduction for large cars, and a shift to a larger proportion of small cars.

The initial cost of cars would not be appreciably increased by a 20 per cent improvement in gas mileage; a 30 per cent improvement would cost about $200; and a 40 per cent improvement would cost about $400. But lower operating and maintenance costs would pay for these increases in about one year for the largest cars and in three to four years for the smallest vehicles.

The capital investment for manufacturing such improved automobiles is about one-fifth the annual investment of automakers and is thus well within their means.

While the researchers recognized that government intervention could ensure such improvements, they also warned of "adverse impacts on the economy, industry, consumers and the costs of governmental administration." — *D.M.*



Trend of Affairs

Trends This Month

Witkars are Amsterdam's answer to personal rapid transit. These small, battery-powered vehicles can range over the city, taking driver and passenger exactly where they want to go for only a small charge.

TRANSPORTATION

Which Car? Witkar.

Although they are noiseless and keep the streets pollution-free, electric cars have largely been discounted as a means of mass transportation because of their limited storage capacity and range of travel. The Dutch are working to overcome these disadvantages by integrating a small, electrically powered vehicle into an innovative system of public transportation.

Last March the city of Amsterdam launched a three-month trial of the Witkar system — two-passenger, battery-powered "white cars," that can travel at 20 m.p.h. within a network of recharging stations located around the city. Its success has led to the ordering of 35 cars to add to the original five and brought the planned number of stations to five. By the end of this year, 15 stations and 125 cars are planned to be in service.

The Witkars are owned by the Witkar Cooperative Association. Nineteen dollars buys a lifetime membership to the Association, a magnetically-coded key, and the opportunity to rent one of the cars at any time. The member inserts his key into the station terminal and selects his destination — the recharging station closest to where he wishes to go — and uses the key to unlock the first car in line at the station's charging rail. When the car is returned to a station, the time in use is automatically charged to the member's account at four cents per minute.

The cars stand 55 inches wide and 86 inches high, a third the size of regular vehicles and a blessing to crowded Amsterdam streets. Recharging time for an average trip of one-and-a-half miles is only about five minutes, so theoretically the cars will recharge at the station's overhead rail while waiting to be used again.

The Witkar concept is the brainchild of Luud Schimmelpennink, long an advocate of noiseless and inexpensive mass transit. When his plan to provide the citizens of Amsterdam with free community bicycles was stymied by political opposition and theft of the bikes, he turned to this form of independent public transportation. It seems to be successful — membership in the Association numbered 2,500 even before the three-month trial period had ended.

Typical Dutch thrift and practicality have also gone into the planning of the recharging stations. An unused windmill near one of the station sites is now being revamped for electrical generation and is expected to provide enough free, nonpolluting power to run three recharging stations. — *S.J.N.*

Long Hauls in the Airlines' Future

High fuel prices and pressure for energy conservation threaten a revolution for the air transportation industry. Unless new technology becomes available, airlines will be pushed out of the short-haul business into concentration on what they do best: long-haul routes and service to communities where ground-based alternatives (train or bus) are not available, writes Joseph F. Vittek, Jr., of the M.I.T. Flight Transportation Laboratory in *Transportation Research.*

Professor Vittek puts it this way: "The industry may have to concede short-haul markets to other modes in order to protect its long-haul superiority."

A secondary victim of future fuel shortages, Professor Vittek says, would be the projected S.T.O.L. (short-takeoff-and-landing) and V.T.O.L. (vertical-takeoff-and-landing) aircraft intended primarily for city-center-to-city-center service (*see* Technology Review, *May, 1972*). Though they are "the gleam in the eye of every aviation enthusiast," writes Professor Vittek, the fact is that such aircraft are "even more energy-inefficient than current aircraft."

Professor Vittek proposes a two-part government program to help ease the transition which he predicts:

— Planning should begin at once to improve ground-based short-haul transpor-

tation on routes such as Boston-New York-Washington, Chicago-Detroit, Philadelphia-Pittsburgh, Los Angeles-San Diego, and St. Louis-Kansas City.
— Government regulation should permit and even encourage airlines to focus services and resources on longer flights which use less fuel per passenger mile.

Without such government intervention, thinks Professor Vittek, steeply rising fuel prices could convert the entire air system into a premium service instead of a mode of mass transportation. — *J.M.*

ENERGY

Tough Problems on the Way to Fusion

Will nuclear fusion be ready by the 21st century — just 25 years from now?

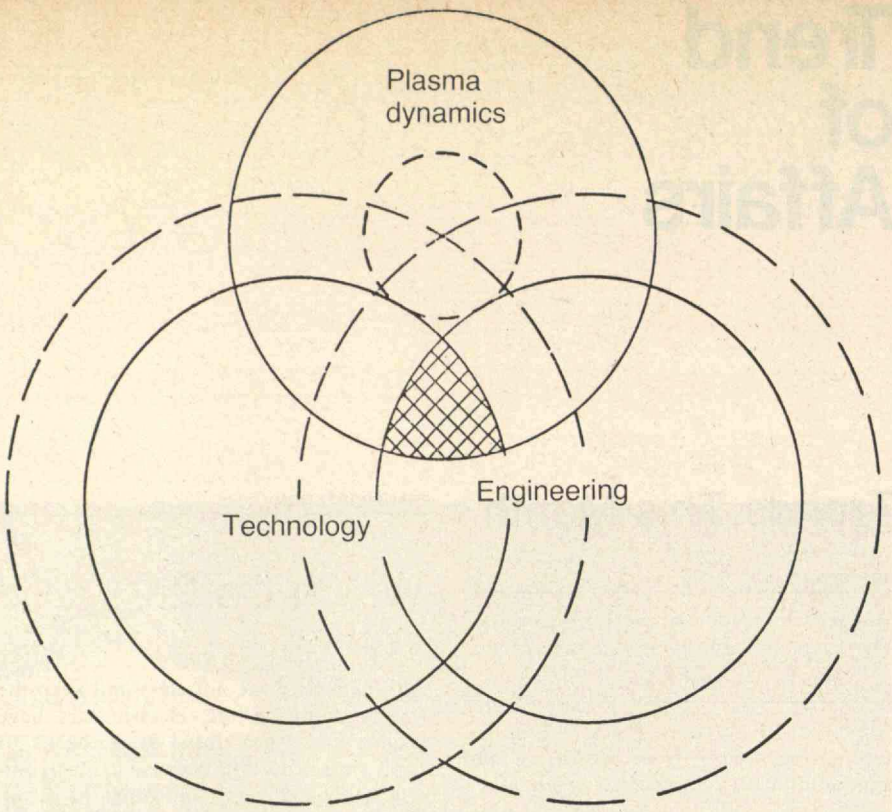
If so, the principal engineering problems should be resolved by 1990. And that is "a very short time for a task so large," think David J. Rose, Professor of Nuclear Engineering at M.I.T., and Robert Carruthers of the Culham Laboratory of the U.K. Atomic Energy Agency.

It was in 1969 that the U.K. Agency and the British Nuclear Energy Society first joined to sponsor an international workshop on fusion reactor design. Five years later the same range of subjects was reviewed by a similar workshop sponsored by the International Atomic Energy Agency. To Professor Rose and Dr. Carruthers it was clear that "much progress" had been made in the five-year period toward understanding "at least the magnitude, if not always the resolution, of a number of important technical questions related to fusion reactors."

But that is far from saying that a fusion reactor will be ready to meet world needs for electric energy by the year 2000 — or even by any other year. Fusion "seems to be on a better track than before," but a wide range of very difficult problems in plasma dynamics, engineering, and technology remain. If the 25-year goal is to be met, the conventional sequence of scientific, engineering, and economic studies must give way to an overlapping pattern of concurrent developments. Only in this way, for example, can the engineering and technology needed for any reactor be ready when (and if) the plasma problems are resolved.

Which brings to the fore the particularly obstinate problem of "excessive disciplinary reductionism" — by which the authors mean the tendency of "any single group concerned with only one phase of the work to use up all design flexibility to solve its own problems, thus leaving impossible tasks for everyone else.

"We were particularly impressed throughout the workshop," write Professor Rose and Dr. Carruthers, "by the degree of simplification forced upon the design of any one reactor part by the requirements of other parts. Thus, in a sort of perverse way, the more complex the reactor, the simpler and more flexible in design concept should each part be." And fusion development "suffers severely" from this difficulty.



"Disciplinary reductionism" — the tendency of the designer of each part of the system to idealize the results which designers of other parts may achieve — is the key problem of fusion reactor design. Any fusion reactor must satisfy requirements in plasma dynamics, technology, and engineering; the reactor exists (if at all) only in the shaded area common to all. "The possibilities in each broad discipline are severely constricted because of the need to accomodate the others."

Unresolved technical problems abound — plasma engineering, startup and shutdown, structure and form, reliability and repair, materials, and environmental effects are among the headings under which they are grouped. For typical comments, consider materials: "Present materials fail in their resistance to radiation damage, creep, and other things by about an order of magnitude," write Drs. Rose and Carruthers. "Developing new materials to the point of engineering acceptance has taken 20 to 30 years per major advance, and we see no reason to believe that materials for fusion will come along much quicker.

"Thus materials development will be a critical pacing item in the future fusion program." — *J.M.*

Emerging From Behind Their Words

Any observer of science can always tell when scientists are becoming more sure of their conclusions; they begin to lose the protective foliage of qualifiers in speech and writing — "present data indicate," "it seems possible," "although further research is needed . . ."

Fusion engineers have been dropping their qualifiers like autumn leaves lately. Although they still admit a lot has to be done in developing plasma confinement, superconducting magnets to hold plasmas, and reactor design (*see above*), they are more confident than ever before that fusion will become a reality by the year 2000.

Some not only predict when, but how. John F. Clarke, Director of the Thermonuclear Division of Oak Ridge National Laboratory, says that the breakeven point in fusion — energy out equals energy in — will be reached in the next six years. What's more, he is as certain as physicists ever are that the first workable fusion reactor will not be laser-ignited fusion, so-called theta-pinch fusion, or mirror-fusion — but the Tokamak fusion machine pioneered by the Russians and improved upon by the Americans.

These latter three fusion methods all rely on enormous magnetic fields to contain the plasmas, differing principally in their geometries and how they heat the plasmas. Theta-pinch machines produce cylindrical plasmas that are "shock heated" by rapidly increasing the sur-

rounding magnetic fields with powerful magnetic fields at either end to reflect escaping plasma particles back into the plasma. Tokamak machines consist of doughnut-shaped chambers into which high temperature particles are injected and heated with electric current.

Although laser fusion projects now underway predict breakeven by 1978, says Dr. Clarke, they will still be far behind Tokamaks in feasibility. This is because the really important number is "engineering breakeven" which means that the massive amounts of energy used in the fusion process are recycled efficiently enough to make the overall process worthwhile. Plasma breakeven takes into account only what goes into the plasma and what comes out, not what goes into a whole power plant and comes out.

Preliminary calculations have shown that the "critical multiplication factors" for engineering breakeven put laser fusion out of the running. A laser fusion reactor would have to generate about 122 times its input energy to be feasible. The theta pinch and mirror fusion methods would have to generate respectively 12 times and two times input energy to be feasible. The Tokamak would have to generate five times input energy to make a useful reactor.

Although the mirror fusion appears to be most advantageous, said Dr. Clarke, the plasma physics of the method predicts that a maximum of only two to three times input energy is attainable, so mirror fusion will be usable only if incredibly high efficiency is obtained.

Although the theta pinch fusion method is still viable, said Dr. Clarke, only Tokamak experimental results look "pretty" enough to warrant a lot of optimism.

Further dumping on laser fusion, Dr. Clarke pointed out that the problems of producing the enormous lasers required to ignite fusion are on a par with producing the plasma itself, whereas many of the technologies for Tokamak fusion are well on their way to fruition.

But, he cautioned, "We're talking about solving an awful lot of problems over the next six years to achieve breakeven; we think we'll get $1.2 billion for fusion projects till then, and we'll need every cent of it." — *D.M.*

The Crunch to Come

If the energy crisis seems overwhelming now, wait until you hear this one.

If electricity demand continues its expected increase, our electricity needs will double every ten years or so. So, whether oil-burning, coal-burning, or nuclear power plants are used, we will need twice as many of them as we now have in ten years and twice that in 20 years.

This means an average of 50 10,000-megawatt power plants in each state by the year 2000 will be required. If conservation measures slice demand in half, the number of plants per state decreases to 30. Or if, as the Federal Energy Administration report on Project Independence recommends, we switch where possible to an all-electric, nuclear economy, 60 more power plants per state will be needed.

Speaking to the New England Council for Economic Development, Dr. Lewis Conta, Dean of the University of Rhode Island School of Engineering drew some discouraging conclusions: "Whether we are talking about 30, 50, or 60 power plants per state, I do not believe we can have this number in operation by the year 2000."

He backs his conclusion with three observations: There will be insufficient numbers of trained personnel in the next two decades to build the plants; enormous capital sums must be raised which must not interfere with the funds slotted for finding new energy sources (already utilities are feeling the squeeze of the capital demands of more exotic projects); and places to build all these power plants must be found.

Power plant siting is not an easy task. Rhode Island has been looking for five years for a nuclear power plant location that would please both environmentalists and consumers of electricity, and still provide the plant with easy access to a million gallons per minute of cooling water. Land-locked states with more limited access to major waterways or lakes will find site location even tougher.

One solution, according to Dr. Conta, is to build nuclear parks, with five power plants in one location, cutting the siting problem by one-fifth. That makes five million gallons per minute of lukewarm water to dispose of, unless wet or dry cooling towers are used. Cooling towers introduce 125,000 gallons per minute of evaporated water to the atmosphere — and the likelihood of inadvertent local weather modification — and no salt-water wet or dry cooling towers to handle a 5000 megawatt plant have yet been built.

Dr. Conta suggests conservation, but beyond that throws up his hands. "Unless we change our direction, soon we will certainly run into an energy crunch more drastic than anything we can now foresee. This will not be a problem only for our children but will be faced by people now in their 30s and 40s even before they retire." — *S.J.N.*

Fuel-Free Electricity

Those who generate our electricity, beset by high fuel costs and imminent shortages, are trying to follow the example of the parsimonious meat packer, who uses everything but the pig's squeal, as they try to squeeze every last bit of useful work out of their fuel.

So imagine their delight when someone advertises a "black box" that uses even the thermodynamic "squeal" of their fuel — waste heat — to generate electricity.

The so-called "organic Rankine cycle" constitutes such a black box. It is essentially a steam engine that uses a relatively volatile organic liquid instead of water to produce gas to turn a turbine. Far less temperature change is required to flash the working fluid into an expanding gas in an organic Rankine cycle than in steam engines. Thus, such an engine can operate from heat sources of far lower temperatures than the steam cycle. As anyone can testify who has ever waited for a kettle of water to boil, water can soak up an enormous amount of heat before turning to steam.

One such Rankine engine is under intensive development at Thermo Electron Corporation, Waltham, Mass. Operating with trifluoroethanol, it can utilize heat sources of 400-1100 degrees Fahrenheit. Although these temperatures are still too high to make practical use of waste heat from the average electric power plant, they do match waste heat temperatures of diesel engine exhaust, gas turbine exhaust, industrial process waste heat, high temperature gas reactor exhaust and even solar and geothermal sources.

Preliminary studies by Thermo Electron for the National Science Foundation have revealed that an organic Rankine cycle added to diesel or gas turbine engines can increase the overall efficiency of the cycle by about 25-50 per cent.

Thermo Electron's cost figures are very tentative, but after all "how much can you afford to spend on a black box that produces electricity for 'free'?" asks Thermo Electron engineer Jerry Davis.

Preliminary estimates show that, at electricity load factors above 30 per cent, fuel costs for most other generation methods would allow a "black box" to cost from $400 to $700 per kilowatt and still be economical. Mr. Davis expects the costs of an organic Rankine cycle generator to be well below that limit.

According to Mr. Davis, the company is planning a full-scale test of a combined 4,300 kilowatt diesel generator combined with a 1,032 kilowatt Rankine cycle generator to run off the 815 degree F. exhaust. The total efficiency for the system will be about 50 per cent, which compares favorably with other power generation methods, and which puts the diesel generator in the running for large power generation stations.

Mr. Davis foresees an all-diesel generating plant consisting of nine such generators (7 operating, two on stand-by) working together to produce 50 million watts of power. A major advantage of such a power plant: in periods of low electric load, generators could simply be shut off, and the overall efficiency of the plant would not suffer. In present steam plants, generators run at low power during off-

load hours are much less efficient than maximum.

A diesel generating plant would also have advantages of a short construction time, easy expansion for larger loads, and the almost total lack of high-technology development problems.

The small size of the plants, combined with their efficiency, might enable dispersed production of electricity, which means more dispersed air pollution and what little waste heat is released; easier siting of the smaller plants; and reduced transmission grids because of the lack of large generating centers. — *D.M.*

PHYSICS

Speeches About Nothing

If nature abhors a vacuum, so must physicists. They have always puzzled over empty space, and have tried for centuries to fill it with structure and properties. Now they are trying again: There is new speculation that the apparent void has qualities which may account for some unexplained processes of the sub-atomic world.

If light travels as a wave, it ought to be an undulation in some medium, just as sound is an undulation in air. But light travels throughout the universe — including through any vacuum that man or nature can devise and man understand. Hence the postulation that some undiscovered medium, which early physicists called ether, permeates all space.

Then in the 1900s came the discovery that the speed of light through space was a constant; either this ether had no inhomogeneities to affect the speed of light, or ether didn't exist at all. And in either case it had become superfluous. Physicists were left with a "vacuum" — a bare stage upon which particles and fields act out their dramas.

Yet this vacuum may still have a structure, provided that the structure does nothing detectable to the velocity of light. Now Dr. Tsung Dao Lee, Nobel laureate from Columbia University, proposes that a new, massless form of matter may be discovered if ordinary matter can be made to interact with a vacuum.

Dr. Lee's calculations, which he gave at M.I.T. this winter at a symposium in honor of Victor F. Weisskopf, an internationally distinguished scientist who has just retired as Professor of Physics at M.I.T., show that an interaction of matter and vacuum cannot reveal itself except under conditions of high energy and high density of ordinary matter over a fairly large volume of space. One possibility is in the collision of the nuclei of two uranium atoms at an energy of 500 million electron volts, provided that the colliding nuclei interpenetrate.

A number of physicists in Dr. Lee's audience wondered if this proposed state of matter might be a source of energy: Neutrons could be fired at the massless thing created by the uranium collision; they would be absorbed and lose mass, and energy would be released. But this speculation is twice removed from reality: It involves imagining a technology that can exploit the predicted form of matter; and validating the prediction will require experiments that are not yet possible.

The vacuum may have other qualities to endear it to theoretical physicists. It might, said Dr. Murray Gell-Mann, Nobel laureate from the California Institute of Technology, account for some problems in current explanations of the subnuclear world. Dr. Gell-Mann reminded his audience that each revolution in physics has failed to embrace a few stubborn facts, and that these facts have always precipitated the next revolution.

The currently stubborn holdouts involve symmetry breaking. In classical physics, symmetries in nature lead to conservation laws — for example, conservation of angular momentum is a mathematical consequence of the belief that space looks the same in all directions. In modern physics, the situation is similar: If a symmetry principle holds, various properties of sub-atomic particles are "quantized" — they can have only certain values. Some of these properties are reassuringly familiar, such as mass and electric charge; others have no counterpart in the comfortable but now untenable world in which atoms are conceived as little planetary systems. "Spin" was the last property for which physicists could even try to make such analogies; they are now resigned to their lot, and quantized properties are given names like "strangeness."

Thus far, almost every particle that has appeared in the particle accelerators has been on the theoretical physicists' list of predictions (one exception seems at first blush to be the new "J" particle — *see p. 59*). But the sub-atomic world has not been as tidy as those lists. Some particles that are not excluded by the calculations seem to be excluded by nature, and there are other disagreements. They come under the heading of symmetry breaking.

Dr. Gell-Mann and others have suggested that this symmetry breaking may be due to the structure of the vacuum and its presumed influence on matter. Thus we may not be so far from a unified view of sub-atomic nature as we thought, Dr. Gell-Mann suggested. The theorists are already producing formulae; Dr. Gell-Mann even displayed an equation, which he credited to a colleague. It contained a pi, a 3, and a logarithm, all of which theoreticians look upon favorably. "I myself think this will be the right formula," Dr. Gell-Mann said, "but it hasn't been derived yet."

Dr. Gell-Mann's only worry about "spontaneous symmetry breaking by the vacuum" was that it might produce unfortunate reports in the press. And in a preemptive strike, he gave his audience the headline that appears above these paragraphs.

Science for People

Everyone bemoans the isolation of the scientific culture from the rest of society. That isolation has something to do with misunderstanding, but two speakers at the Weisskopf symposium (*see above*) proposed that it has little to do with stupidity.

Max Delbrook, Nobel laureate in medicine who now teaches at the California Institute of Technology, traced one misunderstanding back to the writings of Aristotle, which were rediscovered by religious scholars in the Middle Ages. From these writings came the notion of the Unmoving Mover — the agent that acts upon the world but is not itself acted upon. They took this to be the God that had created the universe, and from this came a belief in conflict with the Newtonian one that for every action there is an equal and opposite reaction.

Aristotle's agent that acts but is not acted upon has a very different thrust when considered in the spirit of his biological speculations. Aristotle proposed that the male's semen cannot carry small replicas of the future being, because a child is dissimilar from its father in many physical ways yet similar in nonphysical mannerisms. Yet conception by the female alone is impossible. Semen, Aristotle decided, somehow influences the form of the future being by acting upon a physical substrate to produce an organism, though the semen does not materially manifest itself in that organism.

Thus the Unmoving Mover of Aristotle reveals itself in this century as DNA. (Aristotle was a sexist; menses led him to believe that the female contributed only the substrate.)

This investigation of the past is far from sterile, Dr. Delbrook insisted. The divergent interpretations of the Unmoving Mover represent the different uses of the same symbols that have created misunderstanding between science and religion.

A second form of misunderstanding is more pervasive.

"There are two kinds of knowledge on opposite sides of ignorance," Dr. David Hawkins of the University of Colorado suggested. One kind is scientific knowledge. The other is the unconscious knowledge that builds as we mature, and helps us find our way through the physical world. The difficulty that often arises in comprehending science, Dr. Hawkins proposed, comes when these two forms of knowledge clash. And such collisions come at points so basic that it often seems impossible even to put them into words; no scientist would be likely to do so when instructing laymen.

Two examples of these "loci in the mind where troubles exist almost undetected":

— The reality of air. The ancients gave air equal status with fire, water, and earth. The motions of a column of mercury in Torricelli's barometer were known to reflect the changing weight of the air above it. Still, air isn't as tangible as other things, and most of us have trouble reconciling the belief in air with our perceptual sense that there's nothing there.

Dr. Hawkins frequently tries this experiment on students and science teachers: Turn a test tube upside-down and plunge it into a tank of water. The air in the test tube remains, and keeps water out. Now give somebody a syringe and ask him to try to fill the test tube with water. Most people fill the syringe with water and try to inject it into the inverted test tube. They are puzzled when it remains unfilled. At a time when physicists are worried about the structure of the vacuum (*see above*) most other people have not yet figured out air, said Dr. Hawkins.

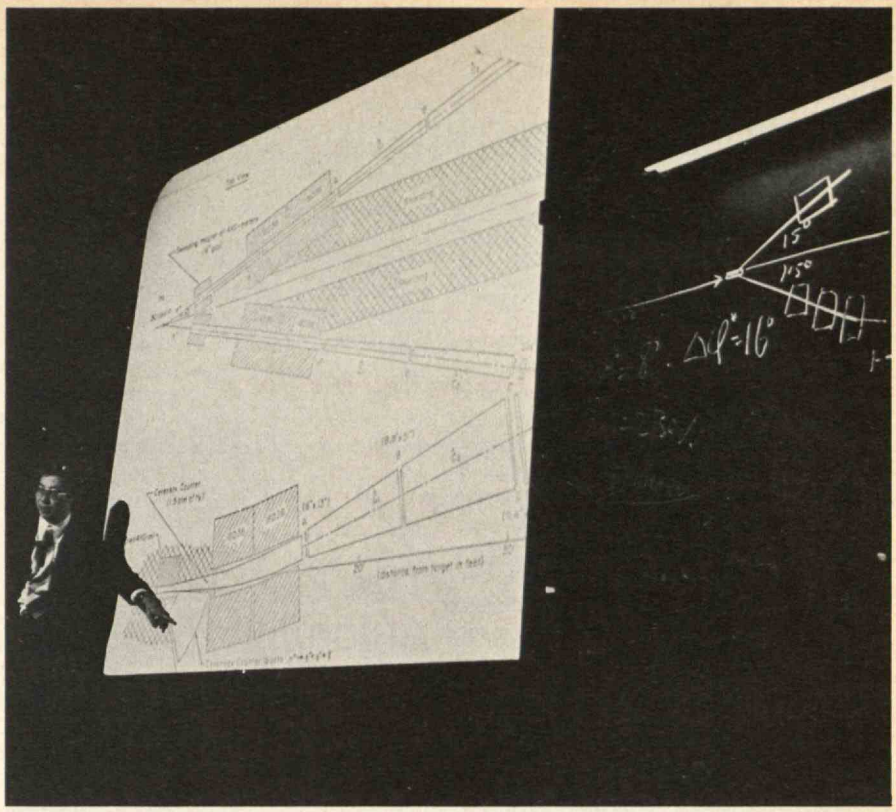
— Mirrors. You are standing in a room, one of whose walls is completely mirrored. Facing the mirror, you see your reflection in front of you. Now somebody else enters the room and looks at your image in the mirror. In what direction does that person look?

Dr. Hawkins has given this problem to a graduate seminar in the philosophy of science. Half of the participants drew a line to the point on the mirror at which you see yourself. They thought of the mirror as a painting — the detail on a painting is seen on its surface. The curious properties of a mirror had been disregarded. In fact, our minds compensate for them: One person told Dr. Hawkins that his bathroom mirror reversed things, but the rear-view mirror in his automobile worked fine.

The physics and mathematics majors in Dr. Hawkins' seminar drew the line correctly, though they may have relied upon the memorized law that the angle of incidence equals the angle of reflection. There is another way to solve the problem: A mirror can be treated as a window, but one that reverses the world. Everyone *does* look at the same place when they look at your image, but that place appears to be behind the mirror face.

Dr. Hawkins has found dozens of these conflicts between the organized knowledge of science and the perceptual knowledge that we possess without knowing it. The sun changes its position during the day, but it is we that are moving; the images in the eye are upside-down; and so on. All of them, Dr. Hawkins argued, are on a level so basic that they are overlooked, or dismissed as "stupidity." But it is conflict at this level that has isolated science from the public.

Meanwhile, geneticists are becoming capable of conducting experiments that may unwittingly unleash dangerous mutant microorganisms upon the world. Nuclear power reactors are producing increasing quantities of radioactive wastes that will remain dangerous for so long that civilizations may change drastically while the wastes remain in storage. Society, Dr. Hawkins noted, will soon be required to make critical decisions arising from knowledge that only a few of us now possess. Dr. Hawkins hopes that some new kind of scientific education will help an entire society to knowledgeably participate in making these decisions.



Professor Samuel C. C. Ting, who led the M.I.T. group which discovered the mysterious "J" particle at Brookhaven National Laboratory late last year, used this diagram to explain his experiment to Brookhaven colleagues. After they were created in the collision of 3-Gev. protons from the B.N.L.'s Alternating Gradient Synchrotron with a target, electrons and positrons moved through two 70-ft.-long arms of a spectrometer. Three magnets and one Cerenkov counter in each arm made possible precise measurement of the energy of the new particles. Some 10,000 tons of steel and concrete were used to contain the radiation produced by protons striking the target. (Photo: Brookhaven National Laboratory from M.I.T.)

Glimpses of a Strange New World

Take comfort. Even the experts are mystified.

Victor F. Weisskopf, who is by any definition a senior statesman of high-energy physics, describes the newly-found "J" particle as "something completely mysterious coming to us from the world of the subnucleus. Nobody knows what it is," Dr. Weisskopf told a convocation at the Institute late last year.

But that mystery does not lessen Professor Weisskopf's enthusiasm for the discovery, which came almost simultaneously at the Brookhaven National Laboratory (by a group from B.N.L. and M.I.T.) and the Stanford Linear Accelerator (by a groupfrom Stanford and the Lawrence Berkeley Laboratory at the University of California) and was announced by the two groups jointly on November 16. Indeed, ignorance of what the "J" particle can represent is the basic source of physicists' excitement abouts its discovery. "It represents matter under completely novel conditions," Professor Weisskopf said — "a new continent where things are completely upside down."

Working with B.N.L.'s Alternative Gradient Synchrotron, a team of physicists headed by Samuel C. C. Ting, Professor of Physics at M.I.T., was systematically searching for new particles by bombarding a proton target with protons at many different energies. They found what they were looking for when they detected a large number of electron-positron pairs produced by protons interacting at 3.1 billion electron volts (Gev.). This indicated the creation of a fundamental particle whose mass was equivalent to that energy.

At Stanford's S.L.A.C., Professor Bur-

ton Richter of Stanford and his associates were experimenting with colliding beams of electrons and positrons — matter and antimatter — which annihilate each other in a flash of energy which can create other particles. As the energy of the colliding beams was raised to 3.105 Gev. there was a similar sudden increase in the output, the result of a particle which the S.L.A.C. group called psi[3105]. Within 12 days a systematic search yielded another (psi [3700]) at an energy of 3.7 Gev.

Both groups reported a surprising inconsistency. The lifetimes of subnuclear particles normally decrease as their energy (mass) increases. The "J" particle is one of the heaviest known — 3.5 times as heavy as the proton. A neutral particle, it decays into other heavy particles — hadrons or leptons and eventually into positrons and electrons — in a period estimated at 10^{-19} sec. (100 billionth of a billionth sec.). On a nuclear time scale this is an exceedingly long life for a particle of such large mass (energy); its predicted lifetime for its mass would be some 10^{-24} sec. Hence the excitement. In their joint press release, Professors Richter and Ting refer to the particle's "totally unexpected properties. . . . It is not like the particles we know and must have some new kind of structure," they said.

"It is just that long life of the 'J' particle," explains Professor Weisskopf, "which might be helpful as a key to the understanding of what goes on inside of the proton. Whatever are the reasons, that long life points to an important new effect within the proton which slows down the ordinary expected course of events.

"It may be a new kind of sub-particle, the so-called 'charmed quark'," Dr. Weisskopf speculates; "or it may be the long-sought quantum of that force which produces radioactivity, another relatively slow process."

Professor Weisskopf clarified the problem in terms of three levels of nuclear energy:

— The atom begins to perform at an energy of about one electron volt, when it "reacts with other atoms, forming molecules, life, and all the surroundings with which we are familiar on earth."

— The world of the nucleus is dormant at energies below one million electron volts. Such energies are now commonplace in high-energy machines on earth, and they occur naturally in the nuclear reactions which power the sun and stars.

— The subnuclear nucleon has an even higher energy threshold — some 1,000 Mev. We know such energies only in man-made accelerators, and we can fully expect matter under these conditions "to behave in a completely new and different manner." This is Professor Weisskopf's "new continent," into which the "J" particle research provides a primitive glimpse. Hence the suggestion of Walter Sullivan, writing in the *New York Times*, that the discovery is "a landmark in the evolution of physics."

Why the "J" particle: Because, like a light wave, this new particle seems to transmit a basic natural force — perhaps, think Professor Ting and his associates, the so-called "weak force" in atomic reactions which drives radioactivity.

Measurements are continuing at B.N.L., S.L.A.C., and other laboratories to determine accurately the new particle's lifetime, spin, charge, and decay modes. The M.I.T. group is also searching for additional particles at B.N.L. and is preparing a new experiment for the international European Nuclear Research Center (C.E.R.N.) in Switzerland, extending the search to much higher energies. — *J.M.*

COMPUTERS

The Coming Age of Automatic Factories

Three-quarters of the metal parts manufactured in the U.S. are made in quantities of 50 pieces or less. Of the time it spends in a metalworking shop, a typical piece is moving and waiting for 40 minutes for every ten minutes it is on a metalworking machine; and of that ten minutes, more than seven are spent in set-up, only three in cutting or forming.

To put one piece of sheet metal through the Metal Fabrication Center at Boeing takes 15 days, 22 handlings and 1,800 ft. of travel; the product will be some 10 to 15 aircraft parts. Two years later, when another customer orders a particular aircraft, the process may be repeated.

U.S. output per man-hour of labor increased 2½ per cent a year between 1963 and 1970, average compensation 6 per cent a year. In Japan the figures were 14.1 and 15.1 per cent, respectively. There is a "steadily increasing reluctance" among workers to take jobs in manufacturing; if present trends continue, only 2 per cent of the labor force will be so engaged by the year 2000.

It is statistics like these, says M.E. Merchant, Vice President of Cincinnati Milacron, Inc., that show why the U.S. must move to automated manufacturing systems in which computers direct machines with little or no human intervention. We are nearing an overdue "technological revolution in manufacturing," he told the winter meeting of the American Society of Mechanical Engineers.

Indeed, he said, the International Institution for Production Engineering Research predicts that more than half of all machine tools built in 1990 will be designed as parts of versatile manufacturing systems; they'll have no "stand-alone" capability at all: The software problems will be resolved by 1980, and complete manufacturing systems governed by central computers will be demonstrated by 1985.

By then, what blue-collar jobs are left in manufacturing will be out of the manufacturing environment and behind nearby computer consoles. The requirements of the Occupational Safety and Health Act (O.S.H.A.) of 1973 will be simpler to meet: There will be no direct contact between workers and machines. And there will have been a fundamental change in the management of the American metalworking industry, says Professor S. Ramalingan of the State University of New York at Buffalo. Software will be the central issue, and sophisticated engineers — not financial managers — will have to be at the helm.

Computer-controlled manufacturing systems look promising even in developing countries, where unskilled labor is plentiful but skilled labor is so scarce it is sometimes priced higher than in the U.S., said A. F. Welch of General Motors Corp. G.M.'s approach is to seek computers to substitute for the missing skilled labor force.

Are such systems the inevitable alternative to the hammer, hacksaw, torch, and lathe of today's small machine shops? Not the only one, thinks Milton C. Shaw, Head of the Department of Mechanical Engineering at Carnegie-Mellon University. Sophisticated manufacturing systems will have great flexibility, but they will have no place in shops geared to quick production of many identical parts; they'll continue to operate with mass-production methods.

It's the gray area between that worries Professor Shaw: When are computer-controlled systems likely to be economical, and what kinds of shops should be investing in them? And will these developments so raise the cost of flexibility as to force standardization, ending our ability to offer ranges of alternative products? — *J.M.*

Flexibility and the Return to Basics

It is sink or swim: If old companies cannot adapt to radically new conditions, meeting the requirements of new efficiency and new thinking, then new firms attuned to today's economics will take their place.

It has always been so. But today's changes are broad, fast, and hard to predict, and margins for error are thin, says John Diebold, head of the Diebold Group. Company survival depends on planning and on effective use of every management and technological tool that promises even a modest advance in efficiency, he said in the firm's annual review this fall.

Every company needs a central staff for planning — not a series of divisional ones — so that an overall balance of risks may be distributed over the entire company. And planning must be dynamic in nature, not depending on extrapolations of cur-

rent rates and levels but instead comprehending enough uncertainty so the company is in fact prepared for large fluctuations in market and financial conditions. Think of the next decades as a period of continuing change, not as one of upsets in a basically stable market, says Mr. Diebold. The strategy is decreased effort on probability determination and more emphasis on contingency planning.

How do computers and information-processing — Mr. Diebold's specialties — enter this scenario? Very directly, since better planning implies greater data and communications capability. A dramatic change is coming in corporate communications, he said — a change in which electronic teleconferencing substitutes for conventional conferences and saves enough in travel expenses to allow a major increase in data-gathering and communication without additional cost.

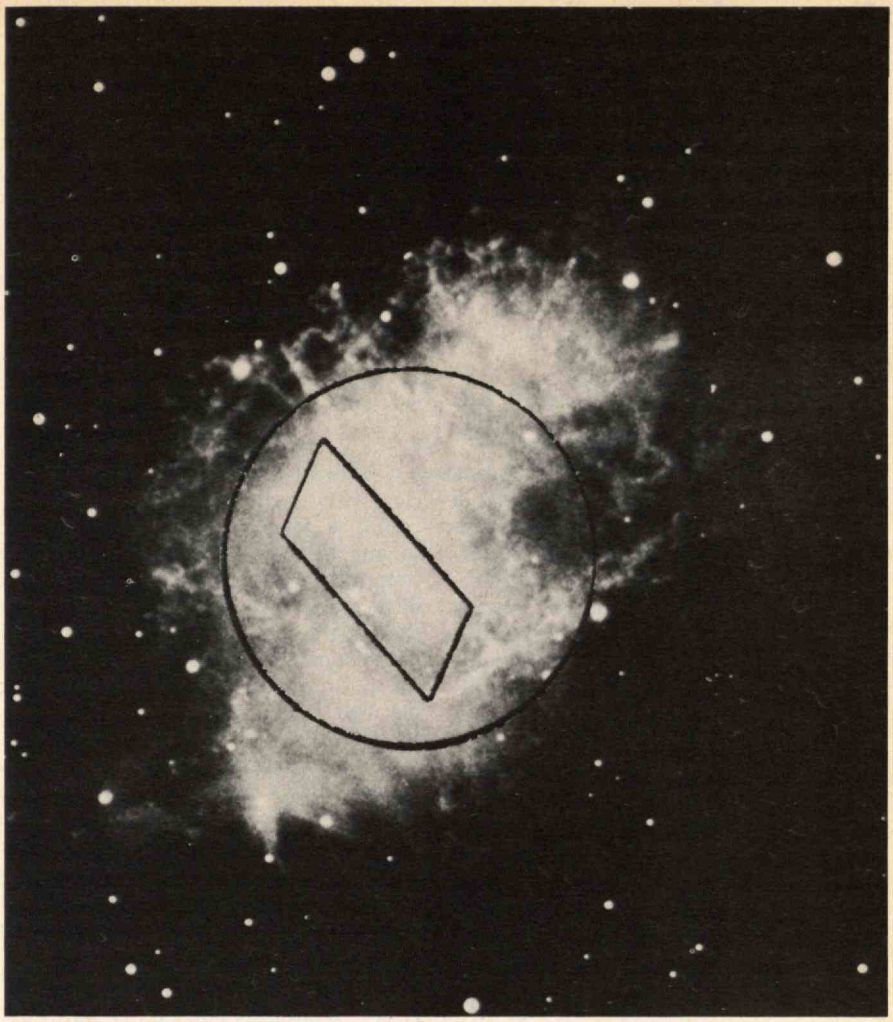
Computers figure in all forms of electronic conferencing: computerized conferences using teletype input to a commercial time-sharing network, computerized conferences using a purchased minicomputer as a message-packet switcher over normal telephone lines, and normal teleconferences using existing telephone networks without computer message control. Costs, already modest by comparison with travel, will decline rapidly as satellite telephone relaying becomes available. Even today, eleven minicomputer-switched conferences can be held for the cost of one travel conference or two telephone conferences. By 1976, thinks Mr. Diebold, the figures may be as high as 17 and four, respectively.

Computer technology is ready to meet such needs, says Frederick G. Wethington, senior consultant for Arthur D. Little, Inc. All minicomputers will soon be interactive, he told an M.I.T. seminar this fall, and terminals will no longer be "brainless," allowing greater ease of editing and use of user-input information. New hardware developments (circuits with ten times the density for processing purposes, and mass storage with a five-fold increase in both size and retrieval time) will improve ease of handling rather than actual problem-solving speed, insuring more interactive capabilities, automatic file management, and system redundancy to prevent downtime. These developments seem to be precisely what is needed to make teleconferencing a more agreeable situation for its users. — *Kenneth Lerner*

SPACE

New Light on the Shining Crab

Seen in visible light, the Crab Nebula — the remnant of a star whose collapse in a violent celestial explosion was observed by Chinese astronomers in 1054 A.D. — is an elongated, filamentary radiator of many colors, one of the great spectacles of the sky. The Crab is also known to contain a pulsar (NP 0532, which is presumably the source of much of its visible energy) and to be a source of many powerful x-rays.



High-energy x-rays come from a small area — the parallelogram — of the Crab Nebula, apparently from whitish wisps which oscillate near the Crab's pulsar. To M.I.T. physicists whose x-ray telescope secured this data in a balloon flight over Saskatchewan in August, 1973, this suggests that the pulsar is the source of high-energy electrons which release the x-rays in the wisps. The circle indicates a previously defined area from which are known to come low-energy x-rays.

Now analyses of results from an x-ray telescope carried by balloon over Saskatchewan in August, 1974, reveal that the x-rays come from a small, elongated area within the Crab which is narrowest in the direction in which the optical radiation is widest. The x-ray area correlates with the location of the pulsar — not surprising — and with structures called "wisps" which radiate whitish light while they oscillate around the pulsar.

The area emitting x-rays is some 20 times smaller than the region that emits visible light. To the experimenters — Professor Walter H. G. Lewin, George R. Ricker, Jr., and Anton Scheepmaker of the M.I.T. Center for Space Research — this indicates that the pulsar is a source of high-energy electrons which quickly lose energy, creating the x-rays. All this will help explain the role of the "wisps" in transmitting energy from the pulsar to the nebula — and eventually, perhaps, define the pulsar's role in relation to the star which was the Crab's predecessor.

This is the first of a number of new findings about the Crab which are likely during the rest of 1975, the result of observations during a series of 20 occultations of the Crab Nebula by the earth's moon which began in August, 1974. The moon, its edge acting as a "shutter" crossing the face of the Crab as seen by the telescope, made possible mapping the x-ray source with great accuracy. Other experimenters will also use this "shutter" effect of the moon to study other characteristics of this most intriguing example of stellar revolution. — *J.M.*

Gosubs, Foul Balls, and Concentric Circles

Puzzle Corner
by
Allan J. Gottlieb

Hi. Perhaps I can make use of my large captive and talented audience. A colleague of mine, Jerry Stoodley, and I were discussing photography last week, and an interesting question in "practical" optics arose. One can use a bellows to convert a normal camera lens into one suitable for close-up work, and one can achieve essentially any magnification ratio by using a long enough bellows or an extension tube. I was told by a professional photographer, whose ignorance of optics I could easily document, that one "should" mount the lens in reverse position when magnification ratios exceed 1:1. This fact seems to be verified by checking some charts put out by Nikon for use with their bellows. Of course, no explanation is offered. Is there some legitimate reason for this, or is it just a myth started by photographic companies to entice people into buying the necessary adapters to mount their lenses in reverse position? Your enticed editor would most appreciate a clear explanation.

Problems

FEB 1 This month we start with an unsolved bridge problem from Charles E. Blair: In *Bridge in the Menagerie,* Victor Mollo gives a "curious hand: Both sides can make four hearts." Actually, the deal is one in which both sides can make four hearts with more or less plausible misdefense. I wonder how close one can get if one insists on best defense. A deal on which both sides make seven no-trump is easy, but can one deal a hand on which both sides make even two hearts?

FEB 2 Frank Rubin wants you to find the set of positive real numbers whose sum is 100 and whose product is maximal.

FEB 3 I suppose this could be called a wordy number problem: If the numbers from 1 to 5,000 are listed in equivalence classes according to the number of written characters (including blanks and hyphens) needed to write them out in full in correct English, there are exactly 40 such nonempty classes. For example, class "4" has three elements (4, 5, and 9) and class "42" has nine (3373, 3377, 3773, 3777, 3378, 3778, 3873, 3878, and 3877). There is a class with exactly one number; what is it?

FEB 4 Jerry Stoodley and I enjoyed solving this one. A little practice with computers or recursive functions would be helpful. Thank you, Dave Kaufman: In the programming language BASIC, each line is numbered and the subroutine call is called GOSUB. It transfers control to a specified line number, as in

10 GOSUB 20.

Control continues as usual from there until a RETURN instruction is read, when control is passed back to the line *following* the GOSUB. When several GOSUBs are executed without intervening RETURNs, they are *stacked*; that is, a RETURN returns to the line following the *latest* pending GOSUB which is then removed from the stack. The next RETURN encountered refers to the previously pending GOSUB, which is then removed. And so on. Assuming a RETURN without pending GOSUB is illegal, can you prove the legality or illegality of this program:

```
10 GOSUB 20
20 GOSUB 30
30 GOSUB 40
40 GOSUB 50
50 GOSUB 60
60 GOSUB 70
70 GOSUB 80
80 GOSUB 90
90 RETURN
99 END
```

Another question: How many GOSUBs were executed?

FEB 5 A magic hypercube problem from Eric Jamin: Everyone knows the 3 x 3 magic square with integers 1 through 9 used once each. Can you build a 3 x 3 x 3 magic cube using the integers 1 through 27 once each? How about a magic hypercube using the integers 1 through 81 once each?

Speed Department

FEB SD 1 Our first speed problem this month is from John T. Rule: Two ferry boats ply back and forth across a river with constant speeds, turning at the banks without loss of time. They leave opposite shores at the same instant, meet the first time 700 ft. from one shore, continue on their way to the banks, return and meet for the second time 400 ft. from the opposite shore. As an oral exercise, determine the width of the river.

FEB SD 2 How far can you lower an endless rope into a bottomless hole? (Think of a real rope, not a theoretical one.)

Solutions

The following are solutions to problems published in October/November.

O/N 1 Black and White are to cooperate to checkmate White in the fewest possible moves, starting from the standard beginning position. What are the moves if Black is constrained to move only one piece with which he may neither capture nor give check (he may, of course, mate with the piece)?

The famous fool's mate is not possible, as Black moves two pieces (King's Pawn and Queen). Most readers (and the editor) submitted three-move solutions similar to the following from Mark Sinz:

1	P-KN3	N-QB3
2	P-K3	N-Q5
3	N-K2	N-B6.

The proposer had a different meaning in mind for the phrase, "may neither capture nor give check," from that which I understood. I added the portion of the problem in parentheses, because that was the only way I could see to understand it. Dr. Rubin intended, however, that the checkmate would have to be by discovery — i.e., discovering check is not giving check. This makes the problem substantially more challenging, so I will not supply an answer to this modified version until the May issue, to give readers a chance to respond.

Three-move solutions were received from John Epstein, Milton Grossberg, Warren Heller, Frank Model, Anne Taft, and William Wise.

O/N 2 From Pascal's triangle of binomial coefficients arranged in rectangular form, find a formula which yields the value of any element in the array (see the top of the next column). In other words, what is $P_{m,n}$?

n: \ m:	1	2	3	4	5
1	1	1	1	1	1
2	1	2	3	4	5
3	1	3	6	10	15
4	1	4	10	20	35
5	1	5	15	35	70

This was an easy problem. All respondents agreed to this. Curiously, however, there was less agreement in their answers. The following solution is from Gerald J. Roskes, who includes an interesting observation on the relationship of the given matrix to another one also derived from Pascal's triangle:

By examining diagonals running from the lower left to the upper right, we see that $P_{m,n}$ is the binomial coefficient defined by

$$P_{m,n} = \binom{m+n-2}{n-1} = \frac{(m+n-2)!}{(n-1)!(m-1)!}$$

Another interesting formula can be obtained by considering the identity

$$(1+x)^{m+n-2} = (1+x)^{m-1}(1+x)^{n-1}.$$

Comparing coefficients of x^{n-1} on both sides of this equation, we find that

$$P_{m,n} = \binom{m+n-2}{n-1} = \sum_{i=0}^{n-1} \binom{m-1}{i}\binom{n-1}{i}, (m \geq n).$$

Let B be the upper triangular Pascal matrix defined by

$$B_{i,m} = \begin{cases} 0 \text{ if } i > m, \\ \binom{m-1}{i-1} \text{ if } m \geq i. \end{cases}$$

$$B = \begin{vmatrix} 1 & 1 & 1 & 1 & 1 \\ 0 & 1 & 2 & 3 & 4 \\ 0 & 0 & 1 & 3 & 6 \\ 0 & 0 & 0 & 1 & 4 \\ 0 & 0 & 0 & 0 & 1 \end{vmatrix}$$

Then, the above equation for $P_{m,n}$ indicates that

$$P_{m,n} = \sum_{i=0}^{n-1} B_{i+1,m}\, B_{i+1,n} = \sum_{i=1}^{n} B_{i,m}\, B_{i,n}, \text{ or } P = B^T B.$$

Thus the Pascal matrix P can be factored into an upper triangular Pascal matrix multiplied by a lower triangular Pascal matrix.

Batters: \ Innings:	1	2	3	4	5	6	7	8	9
1	On base	Out		Out		Out		Out	
2	On base	* →	On base	* →	On base	* →	On base	* →	On base
3	On base		On base		On base		On base		On base
4	Out		Out		Out		Out		Out
5	Out		Out		Out		Out		Out
6	* →	On base	* →	On base	* →	On base	* →	On base	Out
7		On base		On base		On base		On base	
8		Out		Out		Out		Out	

* = At bat when runner is thrown out stealing.

Also solved by Theodore Edison, David Green, Milton Grossberg, Winslow Hartford, Mary Lindenberg, Robert C. Lutton, John Prussing, Ben Rouben, R. Robinson Rowe, Frank Rubin, and the proposer, Harry Zaremba.

O/N 3 Two players on a baseball team each hit a foul ball in every inning of a nine-inning game in which their team was shut out. If neither was the lead-off hitter, what were their positions in the batting order, and how did this happen?

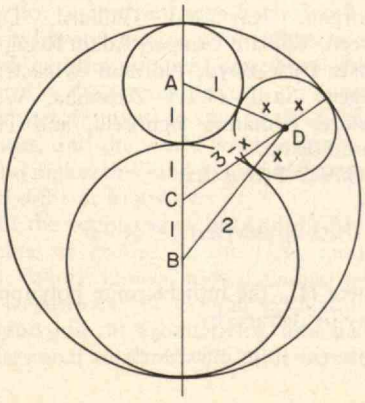
The following solution, in fine diagrammatic form, was submitted by Robert C. Lutton:

The two batters are second and sixth in the batting order. They alternate innings in which one or the other is at bat and has hit a foul ball when a base runner is subsequently thrown out trying to steal, and the same batter leads off the following inning.

The particular order of "Outs" and the "On base" is immaterial, as is the manner of getting on base. However, the runners must not be driven home. Also, the two batters must first hit a foul ball each time before they do whatever is indicated above.

Also solved by: Theodore Engel, Seville Chapman, Milton Grossberg, David Green, M. Kaufman, Rich Rosen, Frank Model, R. Robinson Rowe, Frank Rubin, Leo Sartori, and the proposer, Lars H. Sjodahl.

O/N 4 Given three circles of radii 1, 2, and 3 with the two smaller circles inside the larger, how large a circle can be drawn inside the biggest circle and outside the other two?



For a start, there is a "normal" geometric calculation from Robert Pogoff: The required circle must be tangent to the three given circles. A, B, C, and D are the centers, respectively, of the circles with radii 1, 2, 3, and x. Draw the lines of centers, which intersect the circles at the points of tangency. The segment lengths are:

$AD = 1 + x$ $\quad AC = 2$
$BD = 2 + x$ $\quad BC = 1$
$CD = 3 - x$ $\quad AB = 3$

The area of a triangle with sides a, b, and c and perimeter p (Hero's formula) is

$$A = \sqrt{(p/2)[(p/2)-a][(p/2)-b][(p/2)-c]}$$

In triangle ACD, p = 6; in triangle BCD, p = 6; and in triangle ABD, p = 6 + 2x. Thus,

$$A_{ACD} = \sqrt{3(3-2)(3-1-x)(3-3+x)} = \sqrt{3x(2-x)}$$
$$A_{BCD} = \sqrt{3(3-1)(3-3+x)(3-2-x)} = \sqrt{6x(1-x)}$$
$$A_{ABD} = \sqrt{(3+x)(3+x-3)(3+x-1-x)(3+x-2-x)} = \sqrt{2x(3+x)}$$

$$A_{ABD} = A_{ACD} - A_{BCD}.$$

Thus

$$\sqrt{2x(3+x)} = \sqrt{3x(2-x)} + \sqrt{6x(1-x)}$$
$$2x(3+x) = 3x(2-x) + 6x(1-x) + 2\sqrt{18x^2(2-x)(1-x)}$$
$$6 + 2x - 6 + 3x - 6 + 6x = 2[3\sqrt{2(2-3x+x^2)}]$$
$$(11x-6)^2 = 72(2-3x+x^2)$$
$$49x^2 + 84x - 108 = 0$$
$$(7x-6)(7x+18) = 0$$

Hence $x = 6/7$.

Now we get fancy. Henry Paynter writes, "Being a geometer by preference, I enclose a solution via geometrical inversion, which can at least be visualized, if not actually executed, entirely mentally. Also, such methods generalize readily and have practical applications to physics and engineering." He then proceeds: suppose we take as the circle of inversion that designated IC in Fig. 1 (at the top of the next page) centered at the point 0 common to the two larger circles (A, B) and having radius R = 4. Then under inversion, using $r' = R_2/r$, these circles map into two parallel lines (A′, B′) and the small circle (C) outside IC inverts into a smaller circle (C′) inside IC, all as indicated in Fig. 2

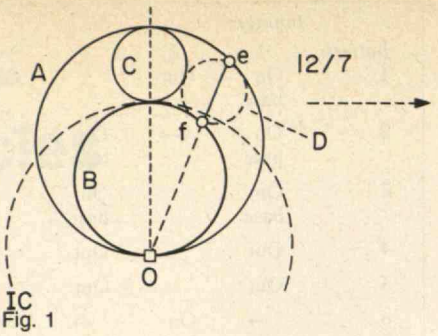


Fig. 1

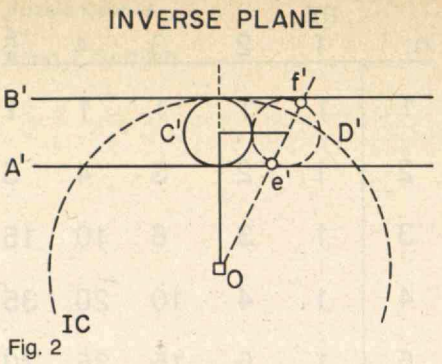


Fig. 2

(see above, right). Clearly in this inverse plane, the solution to the problem is the circle D′, mutually tangent to A′, B′, C′. The diametrically opposite points (e′, f′) along the ray through the center of D′ invert into diametric points (e, f) of the solution circle D, one half of whose separation is the desired answer.

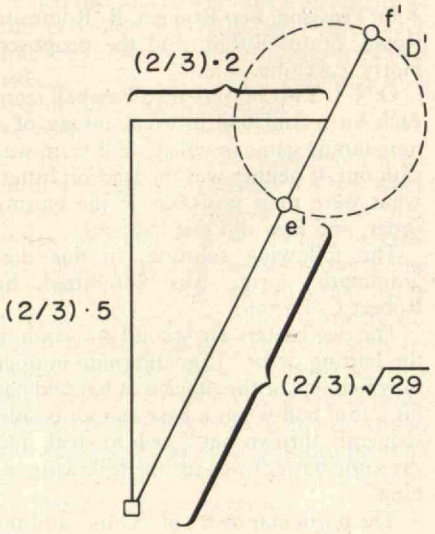


Fig. 3

With reference then to Fig. 3, Pythagoras teaches us that the radial distances of (e′, f′) are $(2/3)(\sqrt{29} - 1)$ and $(2/3)(\sqrt{29} + 1)$, respectively, so that under inversion the corresponding radial distances (e, f) become $(24)\,[1/(\sqrt{29} - 1) - 1/(\sqrt{29} + 1)] = 12/7$ giving us the radius 6/7.

Also solved by Norman Spencer, Daniel Tynan, R. Robinson Rowe, Theodore Engel, Frank Rubin, Milton Grossberg, Robert C. Lutton, Winslow Hartford, Mary Lindenberg, Ben Rouben, Anne Taft, Paul Kaschube, Lars Sjodahl, F. R. Morgan, Raymond Gaillard, David Green, William Cooper, Adam Reed, Hal Vose, Dick Boyd, Norman Wickstrand, Eugene Sard, Harry Zaremba, Waller Moore, Ermanno Signorelli, and Theodore Edison.

O/N 5 Prove that

$$\int_{-\infty}^{\infty} H_{4n+2}(x)\ \mathrm{sech}\,(\tfrac{1}{2}x)\ e^{-\frac{1}{2}x^2}\,dx = 0$$

where H_m, the mth Hermite polynomial, may be defined by

$$H_m(x) = (-1)^m\, e^{x^2}\, d^m/dx^m\,(e^{-x^2}).$$

No solutions have been received for this one.

Better Late Than Never

The solution to the bridge problem published as number 51 (in January, 1972!) is apparently incorrect. Allan Truscot of the *New York Times* has given a defense against which the contract cannot be made. This was pointed out by Frank Model.

DEC 5 (1973) Lars Sjodahl has a counterexample. Of course, he "cheats" by not using a "usual" square but rather one tilted to form a diamond:

```
    2
  1 1
2 - 12
  1 1
    2
```

M / A 1 Eric Jamin has responded that the minimum boards required are 10 x 10 for even boards and 15 × 15 for odd boards. In addition, he claims that no *closed* tour is possible on a 12 × 12 board but that one is possible on a 14 × 14 board.

MAY 5 An anonymous reader points out that it does not follow that Pete is either younger or older than Henry. Thus it is possible that Pete is at the table with Belinda and Henry is with Joe.

JUN 2, JUN 3 Ben Rouben has responded.

J / A 3 Craig Presson and Kenneth Horton have responded.

O / N SD 2 The solution given is not the most general. The general solution is a = mp(n + p), b = mn(n + p), and c = mnp, with m, n, and p positive integers.

PERM 1 shall rest in peace until the arrival of **Y1975** (see last issue).

Proposers' Solutions to Speed Problems

FEB SD 1 1,700 ft.

FEB SD 2 The distance obtained by dividing the breaking strength by the weight per unit length.

Allan J. Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now a member of the mathematics faculty at York College of C.U.N.Y. Send problems, solutions, and comments to him at the Department of Mathematics, York College, 150-14 Jamaica Ave., Jamaica, N.Y. 11432.

Book Reviews

The Coming of Age of Manufacturing Automation

Robotics
John F. Young
New York: John Wiley and Sons (Halsted Press), 1973, 303 pp.

Reviewed by James Lawrence Nevins

Robotics is the first of what I suspect will soon be a wave of books; research and development in what might be called advanced automation systems is attracting world-wide interest. Indeed, it is a movement that has been developing in many countries, including our own, since the mid-1960s.

The most organized approach has been taken by the Japanese, who in 1971 announced among eight national goals the development of pattern information processing systems (PIPS). Such systems had as objectives pattern recognition of speech, printed Chinese characters, and pictures of people and objects, and the ability to read drawings and assemble mechanisms. PIPS is an eight-year project with initial funding of about $100 million; associated industrial projects are budgeted at about $70 million. Allowing for the difference in labor costs, a similar effort in the U.S. would total about $680 million.

In 1972 the Japanese Ministry of International Trade and Industry approved a study project on the methodology for unmanned manufacturing (MUM) — whose first goal is a factory for manufacturing machined parts. It would include automatic assembly of such components as Diesel motors and hydraulic pumps at least to the sub-assembly level and would employ ten workers where 800 are presently required. The factory is proposed to begin operation in 1980, with anticipated search and development costs of $115 million.

The interest of the Japanese stems from their knowledge of technology and its potential and their view of the nature of international competition in the 1980s. There will be one immediate, direct benefit: Pattern input to computers would alleviate a continuing shortage of qualified key-punchers.

In 1970 the Soviet Union announced that one of its goals for the next five years was to perform the necessary research and then to automate 1,500 manufacturing plants. The rationale is that 40 per cent of the U.S.S.R. labor force is unskilled — and of these workers, most simply move things around; only a few use even simple tools. The Soviet Union thus proposes a moral as well as economic purpose in moving people out of these basic, unskilled jobs.

Similar scenarios have been taking place for a number of years in such countries as Norway and West Germany. That is, a consensus establishes national goals for automation systems; cooperatives between governments, universities, and industries are then formed to carry out needed research with government funding. For example, the Norwegians' critical problem is a labor shortage coupled with a national policy of not importing labor. The Norwegians feel they cannot compete in the manufacture of hardware for automation, so they emphasize software and controls. One result is AUTOCON, a system for designing ships which has been sold to many countries, including the U.S. and Japan.

No organized activity currently exists in the U.S. for cooperation between universities and industry with government support on the long-range research that is needed to develop new automation systems for manufacturing. Such work is clearly beyond the scope of industrial research and development programs which require a 40-per-cent return on investment (before taxes) in two or three years at most, and the world-wide shortage of capital makes this kind of investment even more difficult to justify.

But the problem has been studied by a number of groups in the U.S., among them White House special committees, the Department of Commerce National Commission on Productivity, and many professional societies; and understanding of its critical importance is increasing. One of the most active of these "advocates" is the American Automatic Control Council — Automation Research Council (A.R.C.), supported by the National Science Foundation.

A.R.C.'s membership is structured to represent the various interest groups involved in automation in a societal rather than simplistic technological sense. Thus, A.R.C.'s membership includes organized labor, industry, economists, government agencies, and universities and other nonprofit agencies. Instead of simply defining the technological needs for an unmanned factory, A.R.C. is seeking to determine the evolutionary steps necessary to move from a fairly labor-intensive system to a more autonomous one. Among these steps must be demonstrations and trade-off studies to answer the social and economic questions.

The Age of the Robot Is But Dimly Seen

Unfortunately, Mr. Young's book cannot be recommended for the serious student in this important field. It is merely a series of descriptions of activities that include master-slave manipulators (devices directly controlled by people) for use in hazardous environments, specially designed mechanisms for doing highly repetitive tasks, and some limited vocoder speech analysis work done at the author's own university. This work is all lumped under the term "robotics" — in my opinion a totally inadequate concept.

The new systems which we should be trying to understand should be very much more comprehensive, offering flexibility (capability of changing on order from making one part to another), adaptability (tolerance for errors resulting from variations in parts and offering simpler jigging/holding requirements), and programmability (the capacity to be programmed at will to modify or change the product). Such systems will be entirely different from the specially designed mechanisms — called fixed automation — that currently exist for high-volume production. Nor, however, will they be robots, in the sense of fully-programmed replacements for blue-collar — or even

white-collar — workers. Think of these new systems, instead, as comprehensive new tools to help relieve man of mundane, tedious work — methods of making manufacturing processes reproducible and hence of achieving higher reliability in manufactured items to improve their safety and make them more reliable and more economical.

The real challenge in this new work is information and control — what information is necessary to perform a process and how that information should be organized to control it properly. It is true that the new machines suggested here will supplement and perhaps improve the work done by people. But it is going to be a long time before we can talk of systems such as are implied by the term "robot."

Mr. Nevins is the principal investigator on a project for adaptable, programable modular assembly systems sponsored by the National Science Foundation in the Charles Stark Draper Laboratory, Inc.; he studied aeronautics and astronautics at M.I.T. (S.M. 1956).

A Quiet Revolution in Land Use Control

The Use of Land: A Citizens' Policy Guide to Urban Growth
Edited by William K. Reilly
New York: Thomas Y. Crowell Co., 1973, 318 pp.; hardcover $10, paperback $3.95

Reviewed by Bradley Byers

Some books, like good ideas, must be allowed to age before we can know whether their quality is real or apparent.

The Use of Land, when it appeared more than a year ago, received overwhelmingly favorable reviews. It was one of the first important efforts by a semi-official body (a task force of the Presidentially-appointed Citizens Advisory Committee on Environmental Quality) to thoroughly examine the issues involved in the growth-control movement. It offered valuable data that ordinary citizens, including those who make up planning commissions and city councils, could use to support their struggle to remove city planning from the near-exclusive province of developers and their lawyer-lobbyists. As the book itself expressed it: "Our laws and institutions ... reflect a pro-development bias. Although public opinion is now changing ... new rules have yet to be formulated and accepted." But the emerging "new mood" reflected in direct and extensive citizen involvement, it said, can reform land use planning and produce better cities in the future.

No-growth was dismissed as "simply not a viable option," not just because a growing population has to live and work somewhere, but also because it falls short of the American ideal. "Mobility has been a traditional road to opportunity in America [and] wholesale growth restrictions could block that road."

New towns and back-to-the-country schemes such as Peter Goldmark's "New Rural Society" were dismissed because they "have had little success" in the past. Migration into the largest metropolitan centers will continue, and the vast majority of Americans are going to live in urban regions. The task, then, is to build better metropolitan regions in the future. To accomplish this, the book calls for higher density and bigger scale in new construction. Only through larger, coordinated developments can quality be achieved.

This major recommendation keeps faith with the doctrine of the Council on Environmental Quality and the Environmental Protection Agency, where the reigning bugaboo is sprawl. (This is not a remarkable coincidence; editor William Reilly, Staff Director of the task force, was on loan from C.E.Q.) Accepting the inevitability of ever-bigger cities, the authors seek to make them more habitable by preventing sprawl and by clustering development.

But in so doing, they miss the lesson that is apparent in their own chronicle of citizen involvement in planning. Active citizens no longer can be easily persuaded that bigger cities are better cities, or even that the big cities have to grow bigger. The trend of past migration into the cities does not have to be the trend of the future. Just as high birth rates changed dramatically when concern for the environment came into vogue, so could migration patterns change, especially under government incentive.

It has been the fashion, in *The Use of Land* as elsewhere, to attribute to citizen growth-control movements the ignoble motive of keeping out low-income housing. Although this is an element of many such movements, its importance is grossly exaggerated. The groups I know best are dominated by a genuine concern for maintaining the quality of communities, chiefly against commercial and other large-scale encroachment. In the Washington, D.C., area, for example, suburbs have fought the continuing proliferation of office buildings and luxury apartments, which are hardly attractors of low-income families. Rather than opposing all growth, they have opposed perpetuation of the myth that growth is necessarily progress. In their naive way, they have asked the "experts" to find out what growth does to a city — to compare small cities with large, large cities with themselves when they were smaller, and static cities with growing cities — to discover which sizes and which conditions most often produce the healthiest communities. Then, and only then, they believe, will we know enough to plan for quality.

At least three developments since publication of *The Use of Land* should be noted:

— The decline of the homebuilding industry because of inflation and tight credit. The sobering slowdown in construction offers the tantalizing possibility that, with the threat of rampant growth removed, yesterday's growth opponents may become tomorrow's advocates of the carefully staged new development that is essential to municipal vitality.

— Verification of the trend toward migration into small towns. New census estimates now show that nonmetropolitan counties have grown twice as fast as metropolitan counties in the past three years, reversing the trend of the 1960s and offering encouragement for smaller-scale cities.

— A study on City Size and the Quality of Life by Stanford Research Institute, still awaiting publication, has concluded that by measurable standards the quality of life is better in smaller cities and that most people truly would prefer to live in smaller cities if job opportunities existed there. It builds the case for a national policy that offers a choice between large and small.

Today *The Use of Land* stands as an immensely useful document that gives authoritative recogniton to the achievements of the citizen-initiated "quiet revolution in land use control." Its shortcoming is that it has too little faith in the revolution it chronicles.

The author is Public Information Officer of the National Academy of Sciences; he is founder and co-owner of Urban Growth Letter *and founder and first President of the Washington (D.C.) Area Coalition on Optimum Growth, and he was Planning Commissioner of Arlington County, Va., from 1972 to 1974.*

How to Bring Technology to the City

Technology and Civic Life
John Montgomery
Cambridge: M.I.T. Press, 1974; xii + 239 pp., $12.50

Urban Technology
Herbert Fox
New York: Marcel Dekker, Inc., 1973; x + 180 pp., $12.50

Reviewed by David L. Rosenbloom

John Montgomery argues that the sensible application of technology remains the best hope for improving the lives of the people in the "developing" countries; my comments will be limited to sections of

the book that have importance for American cities.

Urban Technology reports on problem-solving workshops held at a national meeting to discuss technological solutions to specific problems presented by urban policymakers. The conclusion is that city officials should think more like engineers, by which Herbert Fox means they should define their problems narrowly. By contrast, Montgomery would move governments toward broader value-oriented participation in technological development.

The books are based on very different definitions of technology. Fox describes a process of applying engineering to specific problems — a concept whose roots are in the reformist literature which holds that cities are nonpolitical service delivery vehicles. Montgomery, on the other hand, describes technological development as a social and organizational phenomenon, a line of argument that can be traced to Arnold Toynbee's description of the industrial revolution as a major change in the social organization. Seen in this light, technological development is a political phenomenon with winners and losers determined by the way in which development is organized. The importance of winning people to voluntarily support change is a natural consequence of this concept, particularly important for local governments. National governments can resort to coercion, but local governments do not have this tool.

The urban technology approach misses this essential point. It tries to separate "technological" and "political" problems, and politics is listed as one of the three principal impediments to technological innovation in cities. (The other two are lack of education within local government about technological solutions and lack of an appropriate technology for some problems.) For example, one workshop was asked to "develop general procedures for implementing a 'management by objectives' system in city government." The essential question of *whose* objectives government is supposed to manage was given short shrift; the major impediment to installing management by objectives was listed as "internal education." Another example of how *Urban Technology* skirts the issue of implementing technological change in cities: The flow chart describing the process. It stops with the words "technology transfer" — as if that were necessarily the logical result of problem identification and the specification of solutions.

By contrast, Montgomery directs us to the relevant questions. Why is technological innovation sometimes not seen to be in the interests of our cities' politicians, bureaucrats, and citizens? Many of the people left living in our cities are themselves the victims of technological change, and they have every reason to fear more of it. Why should a bureaucrat be delighted with a computer that might put him out of work? And, as Montgomery points out, the government that aggressively pushes change risks its own legitimacy. (Any doubters should ask John Lindsay.) There are ample reasons to explain why city officials and residents do not possess a religious faith that "technology" will save them. Support for technological modernization of urban affairs can come only if and when cities adopt the broader developmental perspective suggested by Montgomery; only then can there be a constituency to support change, because cities themselves will plan changes to benefit their residents.

Urban Technology suggests the possibility of a singular national solution to a specified problem which can be sent back down to many cities for application; it misses the essential local element of technological adaptation. Montgomery argues that if a country has no technological capability of its own, it is unable to absorb and adapt technology developed elsewhere; and the same argument can be made for cities. If cities are to benefit from technology and organizational developments, their own research and development capabilities must be increased. Precisely here is the difficulty.

Most city line departments are now fully occupied delivery services. There is no institutional way to develop or absorb new technologies. Outside groups — whether universities or national organizations — have nothing to relate to in most cities. Until *city-based* research and development capabilities exist to play the role of "county extension agent," nationally based urban technology transfer groups will meet with very limited success.

The author, who studied political science at M.I.T. (Ph.D. 1970), is Director of the Parkman Center for Urban Affairs, a research and policy development group affiliated with the City of Boston.

Edgerton

Continued from pg. 9

the wreck, to observe it with television and make overlapping mosaic photographs, and to bring up the camera-strobe-pinger as well as items such as the rudder and loose plates that could be seen on the

"Outstanding Underwater Photographs"

This photograph of a jellyfish *(Mastigias papua)* is from *This Living Reef,* an account by Douglas Faulkner of "a fantastic collection of land and water all mixed up by nature" off Belau (Paulau) in the Caroline Islands (New York: Quadrangle/The New York Times Book Co., 1974, $27.50). Professor Harold E. Edgerton, who has taught and practiced high-speed and underwater photography at M.I.T. for nearly 50 years and whose phrase is quoted in the first sentence, finds it a collection of "outstanding underwater color pictures" covering "a tremendous variety of subject matter." The Faulkner technique involves "a camera system with a great depth of field and used, for the most part, at close range. Flash lighting certainly must be employed to give ample light for these close-up photographs," thinks Professor Edgerton, and he laments that the book gives too few details. Always the teacher, Professor Edgerton especially thinks "such information is useful and important to impart to others."

television. A photomosaic made by the Navy (reproduced in the *National Geographic* article) clearly shows the lost camera-strobe-pinger; but the goal of retrieving this equipment was not achieved.

A third expedition was made to the *Monitor* site in August, 1974, as a search training cruise by the U.S. Coast Guard under the direction of Lloyd Breslau of the Coast Guard's Research and Development Center, Groton, Conn. The goals were to refind the wreck as before and to experiment with Navy underwater equipment. No attempts were made to pick up the deep-sea camera. The *Monitor* was refound and buoyed but not touched or photographed.

A fourth expedition under John Newton as Chief Scientist with support from the Research Committee of the National Geographic Society, Duke University, M.I.T., and EG&G's Environmental Equipment Division was mounted in August, 1974.

Our goals on this expedition, which was based on Duke University's *R/V Beveridge*, a 75-ft. shrimp boat, were to find the wreck and put out buoys, to pick up the camera with a grapnel guided by television, and to attempt horizontal photographs of the *Monitor's* anchor chain, the turret, and the underside of the wreck near the turret.

We did not attempt to pick up the camera because of the apprehension by underwater archeologists that some damage might be done to the wreck in that effort. Our photographic attempts were ineffective due to equipment failures, technician errors (mine), and the difficulty of putting the camera at the exact angle desired during the few days that we were on-site.

It was encouraging to note that our camera-pinger-television combination, which weighed 150 pounds in air, could be placed on the bottom from a 260 ft. line of 3/16 in. steel wire. The wire angle was about 10° when the current was 1.2 knots.

It is my fond hope that the camera now resting over the collapsed crew section on the *Monitor* will be recovered before too long. The film in the camera is exposed and should be developed. If any readers of this article pick up the camera, I appeal to them to send it to me unopened so I can take the film out and process it!

An improved camera and television for horizontal photography is now being developed at M.I.T. with support from the Research Committee if the National Geographic Society with the hope that it can be used effectively at the *Monitor* wreck site in the near future.

Harold E. Edgerton is Institute Professor and Professor of Electrical Measurements, Emeritus, at M.I.T. His exploits in photography and related fields, most of them based on pioneering applications of intense, high-speed strobe lighting, are widely known.

Letters

Continued from p. 5

then Mr. Page's suggestions would be well taken. The situations would be equivalent and the solutions would be identical.

Unfortunately, his analysis rests on an untrue conditional assertion. Being human we college professors would like to establish an enforceable cartel and triple our wages, but we haven't yet figured out a way to do it. The monopoly on knowledge is not as strong as the monopoly on oil. If it were, we also would be defending the tripling of our price on the grounds that it was necessary for efficiency, future production, God, motherhood, and any other handy virtue.

Education as the Fundamental Issue in Science's Service to Society

Victor Cohn's essay on the future of the White House science advisers (*"Some Speculations on Science and President Ford," Oct./Nov., pp. 6-7)* moves me to note that, for all of the emphasis on the advisers' role with respect to research and development, the most significant aspect of our 15-year experience in giving scientific advice to U.S. Presidents has been in the *production* of scientists and engineers. In the United States, our choice of the important scientific issues, including those which come up as factors in government decisions, comes down to the kinds of *people* who will be needed to meet those issues — in the short and long run. Name any field, name any issue, and the question immediately involves education. Do we know enough about the scientific question at hand? Do we have the means to acquire the knowledge needed? If we do, where can it be found? If we don't, where can we go to find it? Who will be available? How can we develop the needed expertise we need?

The words "scientific education" cover a multiplicity of fields, but the issue is clear. Every problem we choose to address, every answer we seek, inevitably involves our system of training an adequate supply of well-educated engineers and scientists to meet the needs at hand, and those now only dimly foreseen.

The Carnegie Commission on Higher Education has highlighted the problems facing all of our colleges and universities — public and private — and the painful adjustments which lie ahead. Meanwhile, a species of U.S. universities known as our institutes of technology are in serious financial difficulty and suffering an identity crisis for a variety of philosophical, educational, political, and financial reasons. They are a special set of U.S. institutions whose commitment to change is perhaps greater than others, because of the nature of their subject matter. They epitomize the problems and opportunities highlighted by the Carnegie Commission in its final report.

The litany of M.I.T., Caltech, Case, Carnegie, Rice, Brooklyn Poly, Georgia Tech, and others recalls an earlier day when these institutions, largely private, and largely strongholds of engineering and science curricula, held sway over the pattern of scientific education in this country. The broadening of scientific curricula, the expansion of the base of U.S. graduate schools, the rise of the public university, and the advent of power politics in federal support for higher education have transformed these unique institutions into semi-carbon copies of their older, more eclectic, more broadly based, more general purpose, university sisters. One need only examine the institutional metamorphosis of these institutes of technology to see graphically what has been happening. Many have merged with other institutions or have literally abandoned the words "institute of technology" in their titles. Are we in danger of losing a precious national resource?

No one can doubt that the grave national issues on which scientific advice has been given to our Presidents were important. The U.S., and perhaps the world, has been granted a few more years to search for peaceful and sensible solutions to national and world problems and to work together for a more decent life as a result of the advice given — some heeded, some not. But the truly glorious and unheralded achievement of the scientific advisory apparatus during the past 15 years has been the national attention given to the need for highly-educated scientists and engineers in helping to solve our national problems. In a word, the need for more and better scientific education, and improvements in the quality of those institutions which prepare students for public service, has been the key advice given.

Are we endangering a species of U.S. university — the private institute of technology — through our collective indifference? Are we also overlooking the scientific and technological leadership which American industry will need from these same institutions in order to do the actual work that needs to be done in the future?

H. Guyford Stever, Director of the National Science Foundation, in a speech given at M.I.T. just over a year ago, struck out at the problem in a new and startling way. He called upon American businessmen and women who are associated with these same institutes of technology as trustees, donors, and sponsors to speak out for American science, to help call national attention to the need for a greater national commitment to scientific and technological pursuits. He asked American industry and the scientific community to awaken and recognize the national need to strengthen our scientific institutions. He reminded us all that we have become entirely too complacent in the matter of our scientific *resources*. He was also reminding us that American science and

technology are not the exclusive province of government, as is commonly supposed, but the necessary province of a private sector determined to see science and technology flourish in the best institutions we have available to support and nourish them.

During a visit to M.I.T. last spring, Clark Kerr stated that if he had to wager on the future of our colleges and universities, the ones which have the best chance of survival in the 1970s and 1980s would be the roughly 1,000 community colleges and the few institutions like M.I.T. which are committed to the application of advanced science and technology to the solution of societal problems facing us all. Allowing for the oversimplification, and for Dr. Kerr's impeccable good manners, his comment dramatizes the problem we face in American higher education — how to serve the scaled-down demand for higher education now forecast by a declining population of college-age youth having reduced ambitions beyond high school, and yet preserve those quality institutions which are the wellspring of highly-trained scientific manpower which this nation sorely needs to maintain its leadership in the decade ahead.

The Carnegie Commission properly concluded that "a new generation of leadership is required if higher education is to design its future and not merely live within the framework that others have built for it." Many observers have pointed out that this process has already begun to produce vital signs of renewal against the national backdrop of shrinking demand. If we plan carefully and provide greater support during this period of transition, we can avoid the costly mistake of allowing our leadership institutions in science and technology to become casualties by forcing them to substitute survival for the search for quality.

Vincent A. Fulmer
Cambridge, Mass.

The writer is Secretary of the Institute, M.I.T. — Ed.

Boulding

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same case against monopoly in the grants economy that we have in the exchange economy. On the other hand, grantors are powerful people, and it is hard for powerful people to give up power, even in the public interest; it is also hard to visualize a single large agency splitting itself up into independent small ones. We do have something like this with the National Institute for the Humanities and its devolution to the states. A study of the effects of this would be of great interest.

Kenneth E. Boulding is Professor of Economics and Director of the Institute of Behavioral Science at the University of Colorado.

Nisbet

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tarctic snow indicated DDT residues as high as 40 parts per trillion, similar to those reported in north temperate latitudes and suggesting global distribution.

Water Transport and Sedimentation

It is well established that chlorinated hydrocarbons in natural waters are closely associated with particulate matter, and that there are locally high concentrations in sediments on the bottom of rivers, lakes, and estuaries. An important unresolved question is whether the chemicals are permanently sequestered in these sediments, or whether they are merely stored there to be released subsequently when the sediments are disturbed. Recent measurements in the Great Lakes suggest the latter: Concentrations of pesticides and PCBs have remained high and there seems to be a rough equilibrium between levels in sediments, water, and the biota. On the other hand, concentrations of these chemicals in some estuaries have locally decreased quite quickly after inputs were cut off; this suggests that the chemicals can be dispersed fairly rapidly from estuarine sediments into the open ocean.

Sedimentation in the deep oceans is a potentially important route of loss of these chemicals from the human environment. PCBs and DDE have already been reported from deep-sea fish, but we do not know whether they were carried there in solution or attached to sinking particles. Recently DDE and PCBs have been identified in stratified sediments in the Santa Barbara Basin off California, in layers dated between 1945 and 1955; this shows not only that these chemicals can reach the sea bottom, but also that they have a very long life there.

As in the case of soils, we have no direct information about the potential for re-evaporation of pesticides from lakes or oceans. Typical concentrations in natural waters are measured in parts per trillion — so low that the possibility of re-evaporation has been dismissed as negligible. But it is now known that pesticides and PCBs are strongly concentrated into surface micro-layers, especially in natural oil slicks. This raises a substantial possibility that they could be re-introduced into the air, either by co-distillation or by ejection in spray from breaking waves.

A Special Puzzle Posed by PCBs

Technical PCBs are mixtures of many different chemicals; those with more chlorine atoms are generally less volatile, less soluble in water, and more strongly adsorbed to surfaces than those with fewer chlorine atoms. Almost all the transfer processes considered in this article — volatilization, co-distillation, dissolution in water, adsorption, and desorption — are known to differentiate the chemicals. Hence it is very puzzling that little differentiation appears to occur in the environment: PCBs found in fish in remote lakes in Labrador scarcely differ in composition from the commercial mixtures. Long-distance transport without differentiation is possible if the PCBs are strongly adsorbed to particles and travel passively with them. However, it is more difficult to explain how they could have been released into the ocean or the air in more or less undifferentiated form. Volatilization of scrap materials in burning dumps has been suggested as one mechanism for release into the air; disposal of marine hydraulic fluids as a possible one for the ocean. But the high concentrations of PCBs reported recently in the water of the Atlantic Ocean are difficult to explain in terms of any known use.

The Importance of Surface Adsorption

This brief survey has provided many examples of our lack of understanding of the key transfer processes for persistent chemicals in the environment. A common thread running is our lack of knowledge of the affinity of these chemicals for particulate matter. We know that they are often strongly adsorbed to particles, and we know that this often controls their environmental behavior. Yet there are virtually no critical studies of this phenomenon and there is no basis on which to predict the behavior even of known chemicals.

George Woodwell of Brookhaven National Laboratory has likened the biosphere to a gigantic separatory funnel, in which lipid-soluble substances such as DDE are partitioned into lipid-rich organisms. In this analogy, the immediate puzzle is why the partitioning should be so inefficient — why only about 0.1 per cent of the remaining DDT and DDE is found in the biota. A partial answer is the small mass of the biota, relative to the water and the air, in which vast quantities of DDT and DDE can be dispersed. But a more important reason is that there is a third phase in the "separatory funnel": a huge volume of soil and sediments into which the DDT and DDE are also selectively partitioned. But for the fortunate circumstance that the chlorinated hydrocarbons are also strongly adsorbed onto particulates, their concentrations in biological tissues would have been much higher. Since their affinity for surfaces has still not been measured or explained, we can count ourselves remarkably lucky.

Ian C. T. Nisbet, who writes regularly for Technology Review, *is a member of the Scientific Staff of Massachusetts Audubon Society. His Ph.D. (in physics) is from Cambridge University.*

An Institute Informant

Inflation and Recession: One Will End and the Other May Not Matter

November 4, 1976, is a magic day: The recession will be over.

Why? Because November 4 is Election Day, and "recessions are not made in heaven — they are made in Washington," says Lester C. Thurow, Professor of Economics.

What about inflation, the second villain in today's gloomy economy?

If one takes an equally pragmatic approach to that problem, one concludes that inflation may not be so much a problem as we think: There are as many winners as there are losers, Professor Thurow told members of the Alumni Advisory Council late last fall.

Four causes of our current economic woes:

— The failure of Presidents Johnson and Nixon to raise taxes to pay for the U.S. military action in Vietnam; both put political judgments over economic ones; they deemed the war simply too unpopular for it to be financed in any other way.

— The devaluation of the dollar in 1971; devaluation was necessary for the position of the U.S. in the international economy, but it raised the price of everything we buy overseas.

— The dwindling stockpiles of food, leading finally to scarcity and rising prices; reducing the surpluses by taking land out of cultivation was a deliberate policy, but perhaps we failed to understand the relationship between low prices and surpluses.

— The Arab oil cartel; a price increase from $3/bbl. to $12/bbl. is "a big stochastic shock to anyone's economy," said Professor Thurow.

One of these four causes of inflation can perhaps be reversed, said Professor Thurow: We need "a very good year" on the farm, he said, a year when food production can dramatically exceed consumption once again.

Three other things — none of them politically possible — could also be done to combat inflation:

— "Recreate the great depression" to make prices go down because of truly falling demand. Such a substantially reduced demand for goods would result in an unemployment rate as high as 15 to 25 per cent, thinks Professor Thurow, and he finds that unthinkable in today's world; "the cure would be worse than the disease," he said.

— Attempt a "social contract" — a plan by which we identify those who have benefited from inflation — farmers, old people (Social Security benefits have risen faster than inflation), oil companies, coal miners — and tax them selectively. Such a "social contract" approach might have been possible had President Ford sought it from his "economic minisummits" when he first came to office, thinks Professor Thurow; but not now.

— Reinstate some form of wage/price controls which would include both production controls and rationing. The point here, said Professor Thurow, would be to correct allocations of capital, restraining some parts of the economy while encouraging others. It's a plan with some appeal, he thinks, except that previous U.S. experience with wage/price controls "does not inspire confidence." They can work "only in the best of times," and President Ford's opposition suggests that this condition would not be met. A tax on gasoline — or on high-powered automobiles — is an example of such a production control — a "simple, trivial" way to reduce consumption; and our failure to enact it, thinks Professor Thurow, is "a good test of how serious we are about dealing with inflation."

Our economy remains stagnant because the U.S. is "on political dead center; we can't decide what to do — whom to help and whom to hurt." So President Ford tries "a mild recession" with unemployment reaching 7 to 7.5 per cent — "big enough to cause problems but not big enough to solve them."

But that recession will be short-lived, thinks Professor Thurow, because the realities of an election in 1976 will begin to affect economic policy by the summer of 1975. The result will be some economic stimulation. It cannot reduce inflation, which Professor Thurow thinks may persist at 8 per cent by the end of 1975; but it will "ease the pain."

Is increasing productivity a viable anti-inflation policy? Professor Thurow was asked from the audience. He is skeptical: Productivity increases tend to look better than they really are, because wages tend to escalate as fast as output.

How to Use Price Controls

No kind of wage/price controls could have controlled inflation in 1973; their role was simply to help us achieve " a more orderly adjustment of prices to new levels," thinks D. Quinn Mills, Associate Professor of Industrial Relations at M.I.T. who was Special Assistant to the Director of the Cost of Living Council during that year of President Nixon's reluctant test of economic controls.

Three suggestions from Professor Mills, writing in the fall issue of the *Sloan Management Review*, if price controls are reinstated:

— Make controls flexible, adaptable to the particular situation in the market concerned.

— Tailor price controls so that they avoid restraining market forces which may tend to increase supplies of goods.

— Don't put too much reliance on price controls; attack the true sources of inflation whenever possible.

A Landmark in the Earth Sciences

A disparate science stalled in a quagmire of geographical and evolutionary detail has been revolutionized in the short space of a decade by a theory first proposed — and discarded in disrepute — a century earlier. There is perhaps no other example in the history of science when a single theory has so rapidly illuminated such a vast terrain.

The science is geology, the theory is plate tectonics — the idea that the earth's continents are drifting across a fluid core from which new material is constantly extruded and into which old material is absorbed — and the decade is the first in the

A huge "earth map" of the U.S., made up of high-resolution satellite photographs, occupies the east wall of the ninth floor lounge — now the new Ida Green Room — in M.I.T.'s Green Building, which houses the Department of Earth and Planetary Science and Department of Meteorology. A dedication ceremony this winter was part of a symposium organized as a tribute to the Greens on the tenth anniversary of the building.

history of M.I.T.'s Cecil and Ida Green Building.

So fruitless seemed the earth sciences in the 1950s, recalls Julius A. Stratton, who was then President of M.I.T., that some thought the Department dispensable. Then came Cecil and Ida Green (he was then Honorary Chairman of the Board at Geophysical Services, Inc.) with their proposal for a new Center for Earth and Planetary Sciences at the Institute. Their foresight was prescient; from the new building at M.I.T. have come some major contributions to the new order. The Green Building has been "a hotbed in the revolution which has shaken the earth sciences," said Frank Press, Head of the M.I.T. Department of Earth and Planetary Sciences during a symposium this winter organized as a tribute to the Greens on the tenth anniversary of the building.

We know that, with the principal exception of ferrous (iron) compounds, the world's major mineral deposits are the result of chemical and physical processes which take place at the boundaries of continental plates — where new material is emerging or old material subsiding. Indeed, it is now possible to turn theory into practice, to predict from knowledge of plate tectonics where to seek rich, new mineral resources, said Patrick M. Hurley, Professor of Geology.

Earthquakes are concentrated at the points of crustal stress, where continental plates rub against each other; one of the world's clearest examples is the San Andreas Fault in California. This understanding, together with new work pioneered in the Green Building on the response of rocks to intense stress, is the basis of today's successes in earthquake prediction, said William F. Brace, Professor of Geology. In the same way, said Professor James B. Combs of the University of Texas (Dallas), active geothermal areas — where the earth's primordial heat reaches closest to the surface — are in the regions of subsidence and emergence.

These are, in fact, the places "where the action is," as Professor Hurley put it.

Has the cataclysm run its course? Not at all, thinks Professor Press. In ten years geologists will be talking not about earthquake prediction but earthquake control, the thermodynamics of plate tectonics (no one yet understands continental drift in terms of heat flow in the earth's interior and through its crust), continental drift measured in millimeters per year, and an all-encompassing theory of planetary histories which does for the solar system what the theory of plate tectonics has done for the earth.

A Busy Summer: 70 Special Programs

Some 70 Special Summer Programs — intensive courses for professionals who need new information on advanced topics or perspective on major issues in their fields — are scheduled for the summer of 1975 at M.I.T. Tuition will range from $450 to $1,000. It's the largest number of such programs ever planned, according to James M. Austin, Director of the Summer Session; full details will be available from his office (Room E19-356, M.I.T., Cambridge, Mass., 02139) after March 1.

Here is the list of 1975 Programs:

Architecture and Visual Studies:
Theory, History, and Practice of Public Celebration, June 23 through July 4; Computer Aids to Design and Architecture, July 7 through 18.

Chemical Engineering:
Modeling, Simulation, and Optimization of Chemical Processes, July 28 through Aug. 6.

Computation and Computer-Related:
Minicomputers and Microprocessors and Their Applications, June 9 through 20; Contruction of Reliable Software, June 16 through 20; Artificial Intelligence, Machine Vision, and Productivity Technology, June 16 through 20; Advanced Software Engineering, Aug. 4 through 15; Computer System and Data Base Performance Evaluation, July 21 through 25; Practical Problems of Computers and Law, July 28 through Aug. 1.

Decision Analysis and Statistics:
Decision Making Under Uncertainty, Aug. 18 through 29; Design and Analysis of Scientific Experiments, June 16 through 27.

Economics:
Urban Economics, Aug. 11 through 22.

Electrical Engineering:
Modern Optics, July 28 through Aug. 1; Optical Communications, Aug. 4 through 8; Techniques in High-Speed Photography, July 7 through 11; Detection, Estimation, and Modulation Theory, June 9 through 13 and 16 through 20; Digital Signal Processing, June 16 through 20 and 23 through 27; Techniques of Pattern Classification, June 23 through 27; Modern Control Theory Methods, July 28 through Aug. 1 and Aug. 4 through 8.

Energy-Related:
Waste Heat Disposal, June 9 through 13; Coal: from the Earth to Energy, Aug. 11 through 22; Energy for Energy Decision-Makers, July 28 through Aug. 8.

Engineering and Applied Science:
Biological Effects, Hazards, and Medical Uses of Non-Ionizing Radiations, July 28 through Aug. 1; Cooperative Phenomena and Phase Transitions, June 9 through 13; Biomedical Physics and Biomaterials Science, June 16 through 20; Laser Instrumentation, July 28 through Aug. 1; Laser Materials Processing, Aug. 4 through 8; Lasers and Optics for Applications, July 14 through 25; Enzymes and Their Use in Analysis and Clinical Diagnosis, June 23 through 27.

Finance and Investment:
Basic Concepts in Financial Management and Strategy, July 28 through Aug. 1; Models for Financial Management and Long-Range Financial Planning, Aug. 4 through 8.

Management:
Methodology and Applications of System Dynamics, June 9 through 20; New Horizons in the Management of Change and

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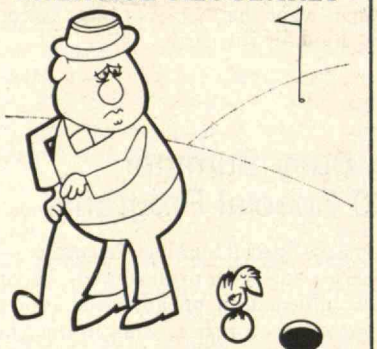

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Organizational Development, July 20 through 25; Motivation in Action, Aug. 4 through 7; Management Control Systems, Aug. 11 through 15; Long-Range Planning Systems, Aug. 18 through 22; Implementation of Computer Systems and Models, Aug. 4 through 7; Dynamics of Health Service Systems, July 21 through 25; Management of Research, Development, and Technology-Based Innovation, June 9 through 20; Management Simulation Gaming, June 9 through 13; Facilities Management Systems and Inventory Techniques, Aug. 4 through 8.

Materials Science:
X-Ray and Electron Optical Techniques for Materials Research, Aug. 18 through 29; Fiber-Reinforced Structural Plastics, July 7 through 11.

Mechanical Engineering:
Dynamics and Control of Rail Vehicle Systems, July 14 through 18; Mechanical Vibration Problems, June 30 through July 11; Noise and Vibration Control, July 27 through Aug. 1; Strain Gage Techniques, July 14 through 18; Physical Measurement and Analysis, Aug. 18 through 29; Manufacturing Systems, July 7 through 11; Modern Manufacturing Analysis, July 14 through 18.

Nuclear Engineering:
Physical Aspects of Nuclear Medicine, July 28 through Aug. 1; Structural Mechanics in Nuclear Power Technology, Aug. 4 through 8 and 11 through 15; Nuclear Technology and Economics, July 14 through 18; Nuclear Power Reactor Safety, July 7 through 11, 14 through 18, and 21 through 25; Principles of Nuclear Fuel and Power Management, July 21 through 25 and 28 through Aug. 1.

Nutrition and Food Science:
Advances in Human Nutrition Knowledge, July 21 through 25; Fermentation Technology, July 28 through Aug. 1; Engineering Foods: Technological, Nutritional, and Marketing Inplications, July 21 through 25.

Ocean Engineering: Legal and Policy Aspects of Ocean Resources Management, July 21 through 25.

Technical Writing and Editing:
Communicating Technical Information, Aug. 11 through 15.

Transportation:
Analysis and Design of Transportation Systems, Aug. 4 through 8 and 11 through 15; Air Transportation Systems Analysis; June 16 through 20 and 23 through 27.

Urban Systems:
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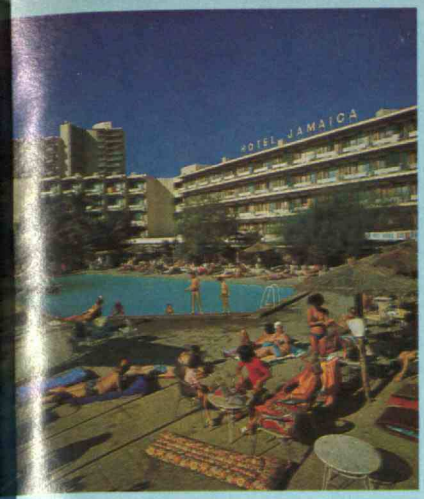

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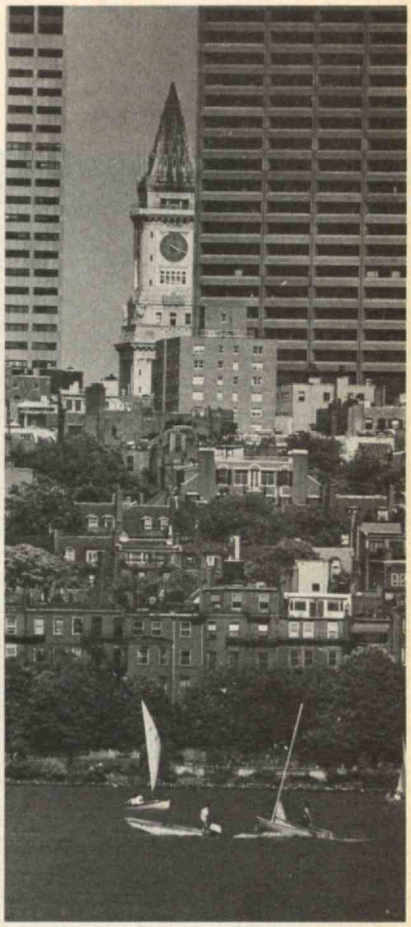

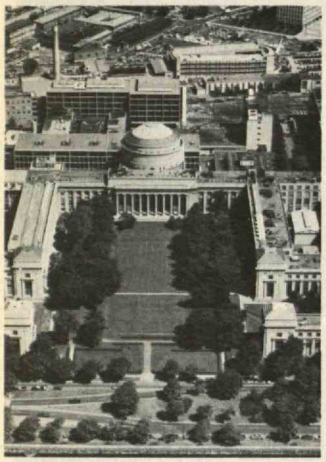

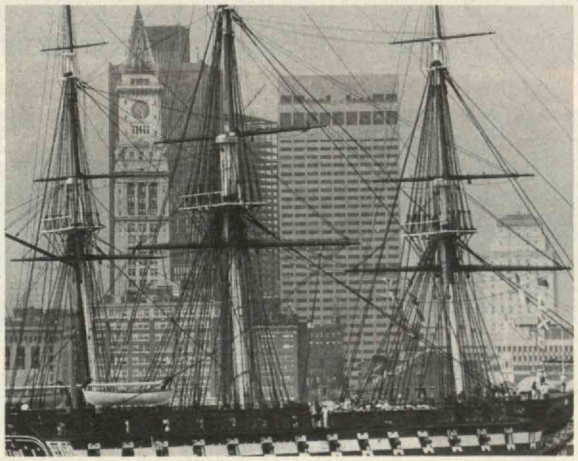

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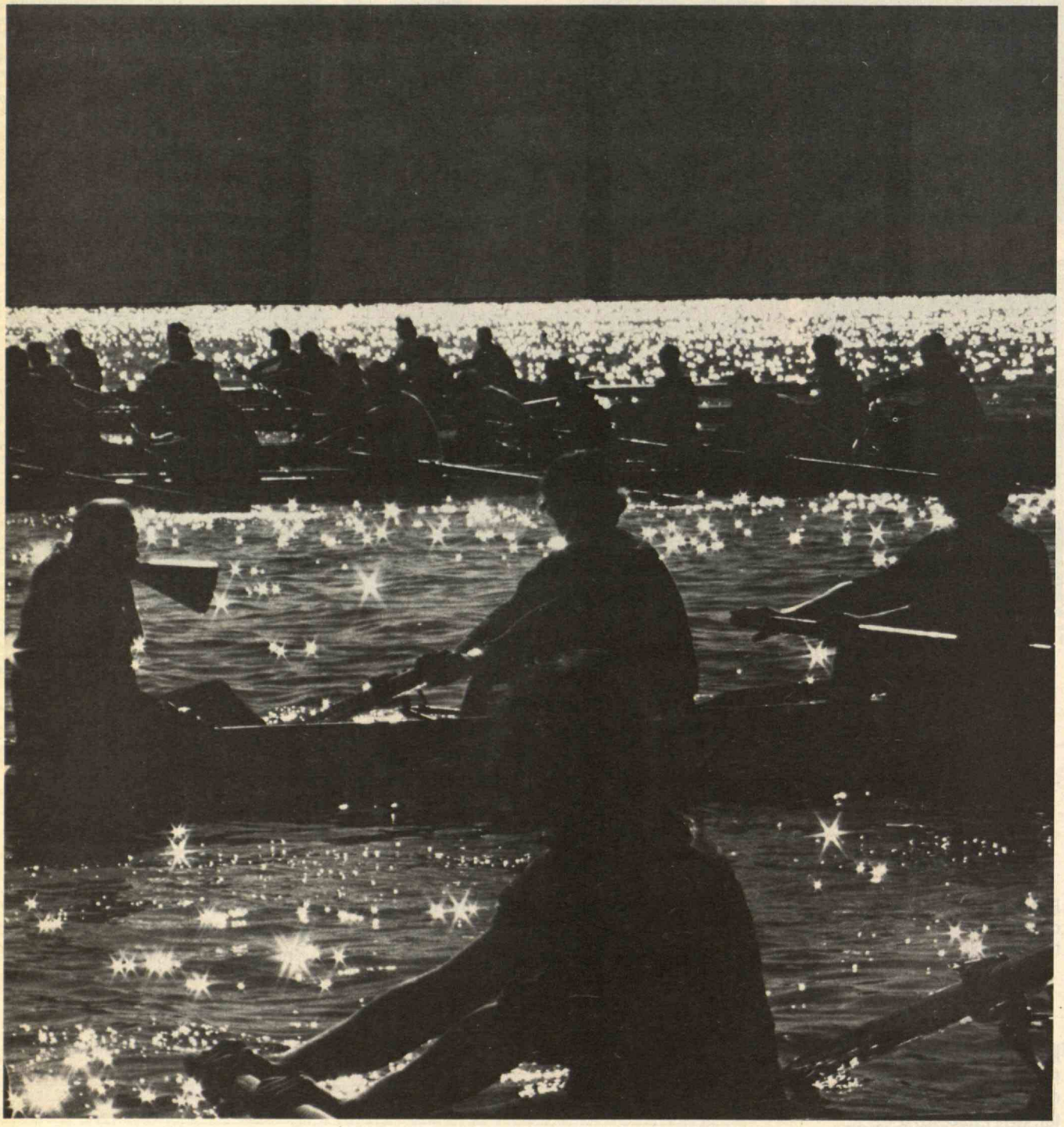


Institute Review

In This Section

The Alumni Association has new leadership (and this magazine a new Publisher) **(pages 79-80)**, and still more new leaders are proposed for alumni activities in 1975-76 **(pages 81-82).**

Just a decade ago Cecil and Ida Green cut the ribbon to the Green Building; an eventful ten years later they return to help us commemorate the event — and to be honored anew **(page 80).**

Good deeds abound: students search for toys which might spoil the day after Christmas **(page 86)** and help a "people's park" in Boston **(page 87).**

A cheering section for the advent of spring appears — in the form of a report on sailing at M.I.T. — on **pages 89 and 90**; but lest your dreams be led astray, there is a (slightly) tardy report on fall sports, too **(page 90).**

Everyone was happy (including especially the lady herself) with the first guest conductor in the history of the M.I.T. Symphony Orchestra **(page 97).**

Fifty-nine boats — the largest number ever — participated in last fall's Class Day Regatta, an annual intramural event which is coordinated by the M.I.T. Boat Club and open to anyone in the M.I.T. community. At the left, approaching the starting line, are six shells in the Senior/Intermediate Eight-Oared finals; the eventual winner: the Sigma Alpha Epsilon entry whose coxswain, Roseanna Means, '76, stroke, Peter Beaman, '76, and seven-man, Craig Christensen, '76, are in the foreground. (Photo: David Schaller, '78, from The Tech.)

New Leadership for the Alumni Association as "their Man at M.I.T." Moves to the Institute

After 26 years of service to the M.I.T. Alumni Association, Donald P. Severance, '38, Executive Vice President since 1962, has resigned to accept the major new post of Director of the Volunteer Leadership Appeal in the M.I.T. Office of Resource Development. He has been succeeded as Executive Vice President — the senior officer in residence — of the Alumni Association by James A. Champy, '63, who will also be, as was Mr. Severance before him, Publisher of *Technology Review*.

Mr. Champy's nomination for the new post came from a search committee of the present and three former Presidents of the Association — Luis A. Ferre, '24, William S. Edgerly, '49, Breene M. Kerr, '51, and Paul V. Keyser, Jr., '29. Mr. Ferre told the Board of Directors at their December meeting that the committee was especially influenced by Mr. Champy's experience and interest in all aspects of M.I.T. life in recent years.

Mr. Champy, who studied civil engineering at the Institute, has been a member of the Corporation since 1969 and of its Joint Advisory Committee on Institute-Wide Affairs since that Committee's founding; he has been Chairman of the Committee since 1971. As a graduate student, Mr. Champy (he holds the S.M. awarded in 1965) taught computer applications; he then went on to Boston College Law School, and since 1967 he has had a private practice in corporate law in Cambridge and Lawrence,

Howard W. Johnson, Chairman of the Corporation, forecasts that "a new partnership" will be forged "between the Institute's traditional and new constituencies in developing urgently needed support over the next decades" by these two men in new assignments effective January 1. Donald P. Severance, '38 (left), became director of the Volunteer Leadership Appeal in the Office of Resource Development, and James A. Champy, '63, succeeds Mr. Severance as Executive Vice President of the Alumni Association and Publisher of Technology Review.

Mass. Election to the new post means that he gives up both his law practice and his membership on the M.I.T. Corporation — the latter under a provision of the M.I.T. Charter.

Both new appointments became effective January 1.

Howard W. Johnson, Chairman of the M.I.T. Corporation, was generous in praising the progress of the Alumni Association under Mr. Severance's "imaginative leadership." Since 1948, when Mr. Severance was named Secretary and Treasurer of the Association, there have been "significant achievements," said Mr. Johnson: "The Alumni Fund has grown from $170,000 to $3,200,000 in annual giving, alumni activities have brought thousands of alumni into closer relationship with the Institute and the professions it serves, and *Technology Review* has achieved a unique role as a professional and institutional publication."

But James B. Lampert, Vice President for Resource Development, with whom Mr. Severance is now starting work, has an even stronger claim: "Mr. Severance's knowledge of the Institute's 60,000 alumni and the confidence they have shown in him during his 26 years of service to the Alumni Association will be vital in our efforts to assure new resources for teaching and research," he wrote in the official announcement.

Mr. Severance first joined the M.I.T. staff in 1940, and he served as Assistant Registrar from 1941 to 1948. He is known as "their man at M.I.T." by countless alumni throughout the world, and the effectiveness of the growing Alumni Association on staff in maintaining communications and increasing understanding of the Institute among its former students is his principal achievement as Executive Vice President. □

On the tenth anniversary of the Cecil and Ida Green Building, its student-faculty lounge was refurbished and named in honor of Mrs. Green, whose portrait now graces one wall of the room. There was a small ceremony with Howard W. Johnson (left, above), Chairman of the Corporation, and Dr. and Mrs. Green as principals. Professor Jule G. Charney of the Meteorology Department spoke of the value of the room: Without it "we would be individuals working alone," he said. Since the room was first created, thinks Kate H. Hadley, a graduate student in earth and planetary sciences, perhaps 12,000 cups (18 bbl., in today's geologic terms) of coffee and as many cookies may have been consumed at student-faculty gatherings in it. The new room is more commodious and more comfortable, and even more students will enjoy it in the future, she said.

The Ida Green Room: More Than Bones in this Scientific Revolution

When Cecil H. Green and Julius A. Stratton — they were both members of the Class of 1923 — picked up their two-handled shovel to move the first earth for construction of the Cecil and Ida Green Building in 1962, they were supposed to encounter a collection of soup-bones liberated from the nearby Walker kitchen and buried by some enterprising participants in a student hack.

The prank went astray because the ceremony was moved. And in any case the students were wrong: Geology was far from a moribund science of old rocks and bones; it was in fact at the brink of a revolution *(see pp. 70-71)* in which inhabitants of the Green Building were to play a major role.

To celebrate this ten-year achievement in "the new wave of exploration in the earth sciences" and what Dr. Stratton called "the profound effect . . . of the Greens' judgment, wisdom, and enthusiasm," the Greens returned to M.I.T. on December 4 for the dedication of a new student-faculty lounge to Ida Green.

Robert R. Shrock, Professor Emeritus of Geology, handed Mr. Green a commemorative book containing a reprint of each faculty member's "most important paper" written during the decade in the Green Building. It was just the right gift, said Cecil Green. "Our objective," he said at a dinner for himself and Mrs. Green, "was not to create a memorial"; they take pride in the way the building is being used and in the work coming from it, and these "have completely fulfilled our dreams and ambitions."

Though he admitted that both Greens are "unique," Howard W. Johnson, Chairman of the Corporation, reserved for Ida Green his special tribute at the dedication: The room, he said, is named because of "her steady, consistent, and wise support of education, her resolute effort to improve the climate of life, her character . . ."

That suited Mrs. Green. "It's just wonderful!" she said. ". . . a deep, abiding gratitude, I feel very humble." □

Strengthening Ties With South American Alumni

Symbiosis is the central idea. Foreign alumni should bring to their own countries the expertise of M.I.T. to help solve current crucial problems. They should feel that M.I.T. is a "humming center" whose activities they can reflect — and maintain contact with — when they graduate, thinks Luis Ferré, '24. "That is the idea we took with us on our trip to South America," he said.

For ten days in November, Mr. Ferré and Dean William F. Pounds of the Sloan School of Management informally exchanged ideas with leaders in government, industry, and higher education in Colombia, Venezuela, and Peru, strengthening ties with these alumni and seeking the foundations for a constructive relationship.

"We first went to Colombia, where we met with M.I.T. graduates in the government," Mr. Ferré told us. There is an astonishing number in the Executive Branch and in Congress:

— Sr. Rodrigo Botero Montoya, '56, Minis-

ter of Finance
— Dr. Eduardo del Hierro, '56, Minister of Energy and Mines
— Sr. Rodrigo Uribe, '41, Presidential Adviser
Sr. Hugo Belalcazar, '54, Governor of State of Narino
— Dr. Antonio Barrera, '67, Director of Budget
— Dr. Guillermo Perry, '70, Director of Internal Revenue
— Sr. Ivan Obregon Sanin, '66, Head of Planning Office of the Ministry of Finance
— Dr. Virgilio Barco, '43, Senator for Cundinamarca
— Dr. Bariano Ospina Hernandez, '49, Senator for Antioquia

"Here especially," said Dean Pounds, "the alumni have a warm, overwhelmingly positive attitude toward M.I.T. and toward each other — an old-school-ties warmth."

They discussed questions of help from M.I.T. on research projects to develop Colombia: the rich coal resources; the 150,000 Mw. of energy potential in Colombian water power; government management of finance; their new tax structure; analyzing industrial profit and loss; the great possibilities for development of the riches off the Caribbean and Pacific coastlines; agricultural production and distribution. Colombian students studying at M.I.T. could choose projects, it was suggested, that would prepare them to help their country upon their return, and American M.I.T. students might find summer work or even professional careers in Colombia.

Venezuelans are intent on "converting natural resources into human resources," said Mr. Ferré. "Their theory is that natural resources in oil are expendable; before these are heavily spent, they want something permanent as well — the education of their students. With this money, they will send 10,000 students with scholarships each year to take technical courses both in communist countries and in our capitalist society."

To build a strengthened link between these countries and M.I.T., committees could be formed, thinks Dean Pounds, to:
— Direct programs of interaction with M.I.T. to facilitate project work.
— Arrange summer job opportunities for M.I.T. students not limited to the United States. The students would be exposed to new countries, their education serving as a valued source of technical knowledge.
— Place appropriate graduates (of any nationality) in jobs within other countries.
— Organize a big, visible, Andean alumni activity to draw alumni from all Latin American countries once a year.

"The alumni we visited in these countries feel now," said Mr. Ferré, "that they have something more important to do than raise money, . . . that they can use their influence in a constructive way, to bring to their countries the technical education needed to solve pressing problems." □

Eleven Nominees for National Jobs

Who will lead the $1 million operations of the Alumni Association in 1975-76, and who will join the Corporation to represent the Association's 60,000 members in M.I.T.'s major policy decisions?

In practice — though not necessarily in theory — the answers are determined by the choices of the National Nominating Committee; accordingly, 11 alumni chosen by that Committee are assured of places in the 1975 national election of the Association, for which ballots will be mailed early in April.

With them on the ballot will be a proposed constitutional amendment under which the Nominating Committee will become the Selection Committee, charged with the task of choosing national officers. The proposal provides for three candidates for each vacancy on the Selection Committee, and the choice among these nominees will continue to be by a national ballot of the Association.

The 1975 nominees for Corporation members and alumni Association officers:

For Term Members of the M.I.T. Corporation:

— **Norman B. Leventhal,** '38, General Partner, the Beacon Companies, Boston. Mr. Leventhal entered the construction field after graduating in civil engineering; he is now a Trustee of Property Capital Trust and Vice President of a nonprofit corporation devoted to housing for the elderly, and he is a past President of the Associated General Contractors of Massachusetts and a former Director of the Associated General Contractors of America. A member of the Corporation Visiting Committee for Civil Engineering and of the Corporation Development Committee, Mr. Leventhal is President of his Class and a member of the Alumni Fund Board; he is also President of the Combined Jewish Philanthropies of Greater Boston and Vice President of Beth Israel Hospital, and he is active in community affairs in Worcester, Mass.

— **Wilfred D. MacDonnell,** '34, President and Chief Executive Officer of Kelsey-Hayes Co., Romulus, Mich. After completing his degree in metallurgy, Mr. MacDonnell held positions with Bethlehem Steel Co. and National Steel Corp. (of whose Great Lakes Steel Division he was President and Chief Executive Officer) before joining Kelsey-Hayes in 1962; he is also Director and Vice President of Fruehauf Corp., a Kelsey-Hayes division. Mr. MacDonnell is Area Council Chairman (Detroit) for the Alumni Fund, a member of the Corporation Development Committee, and a former member of the Corporation Visiting Committee for Metallurgy; he is a member of the National Academy of Engineering, and he has been prominent in civic activities in the Detroit area.

— **William J. Weisz,** '48, President and Chief Operating Officer of Motorola, Inc., Chicago. Mr. Weisz studied electrical engineering at M.I.T. and before taking his present post was Vice President and General Manager of Motorola's Communications Division; he is active in the Electronic Industries Association (a member of the Board of Governors) and the Institute of Electrical and Electronics Engineers, of which he is a Fellow. At M.I.T., Mr. Weisz is a member of the Corporation Development Committee and of the Visiting Committee for the Sloan School of Management, and he has been a Director of the M.I.T. Club of Chicago since 1967.

For President of the Alumni Association:

— **Howard L. Richardson,** '31, consultant, of New Britain, Conn. Trained in electrical engineering, Mr. Richardson has held responsible management positions in General Dynamics (Vice President), the Stanley Works (Executive Vice President and President), and GTE/Sylvania (Senior Vice President). He was Vice President of the Alumni Association in 1966-68, and has been a leader in all aspects of the Association's activities in the New York City and Connecticut areas. Mr. Richardson is also a member of the Corporation Development Committee and has held assignments on several Visiting Committees.

For Vice Presidents of the Alumni Association:

— **Paul L. Hotte,** '42, Vice President – Public Affairs, P. R. Mallory and Co., Inc., Indianapolis, and President of the P. R. Mallory Foundation, Inc. Mr. Hotte was elected to the Board of Directors of the Alumni Association in 1973, upon completion of a three-year term as a member of the Alumni Fund Board; he has also been active in the M.I.T. Club of Indianapolis, serving as its President in 1961-62. He holds bachelor's and master's (1942) degrees in electrical engineering.

— **Ellis C. Littmann,** '33, President and Chairman of Nixdorff-Krein Manufacturing Co., St. Louis. Mr. Littman's company manufactures a diverse range of industrial and farm equipment, including also exercise equipment and furniture; he studied at M.I.T. in the Department of Business and Engineering Administration. Mr. Littmann holds the Award of Merit of the Engineers Club of St. Louis (1973) and the Bronze Beaver (1969) of M.I.T.; he is currently a member of the Alumni Fund Board and was for two years (1969-71) a member of the Association's Board of Directors. He is also Estate Secretary and Vice President of his Class, and he was President of the M.I.T. Club of St. Louis in 1952-53.

For Members of the Board of Directors:

— **Herbert H. Dow,** '52, Secretary and Director of Dow Chemical Co., Midland, Mich. The grandson of the founder of the company, Mr. Dow joined the firm upon grad-

H. H. Dow

C. K. Holmes

P. L. Hotte

N. B. Leventhal

E. C. Littmann

J. K. Littwitz

W. D. MacDonnell

C. J. Matthew

J. F. Moore

H. L. Richardson

W. J. Weisz

uating in general engineering from M.I.T., and he has since then held a number of management posts culminating with his election as Secretary in 1968. He is a member of the Corporation Development Committee and of the Visiting Committee for Chemical Engineering; and he was a member of the National Sponsoring Committee for the new chemical engineering building now under construction.

— **Charles K. Holmes, Jr.,** '49, Vice President of Coca-Cola U.S.A., Atlanta, Ga. Mr. Holmes is Director and has been President of the M.I.T. Club of Atlanta; earlier he was Vice President and President of the M.I.T. Club of San Francisco, and he is a member of the Club Advisory Board. He is also a member of the Alumni Fund Area Council in Atlanta and formerly was a member of the same group in San Francisco.

— **James K. Littwitz,** '42, Director of Special Projects, U.S. and Canadian Photographic Paper Division, Eastman Kodak Co., Rochester, N.Y. Mr. Littwitz joined Kodak in 1945; his M.I.T. degree is in the field of chemistry. He has been active in the M.I.T. Club of Rochester and is now a member of the Club Advisory Board; he is also Regional Chairman for the M.I.T. Educational Council, and he has participated in Rochester-area Alumni Fund programs.

— **Christian J. Matthew,** '43, President and Chief Executive Officer of Lester Gorsline Associates, Terra Linda, Calif. Mr. Matthew's firm is a subsidiary of Arthur D. Little, Inc., devoted to planning and management work for health-care institutions; his M.I.T. degree is in chemical engineering, and he joined A.D.L. immediately upon graduation from the Institute. He has been a member of the Educational Council since 1954, was President of the M.I.T. Club of San Francisco in 1958-60, and is active in Alumni Fund work in the San Francisco-Marin County area.

— **Joe F. Moore,** '52, President of Bonner and Moore Associates, Inc., Houston; President of Scanner, Inc., Houston; and Director of the Chemshare Corp., Houston. Mr. Moore, whose M.I.T. degree is in chemical engineering, has been an active member of the M.I.T. Club of South Texas, and he was a member of the Club Advisory Board from 1970-73.

Additional nominations for these vacancies on the 1975 National Ballot may be made to the Secretary of the Alumni Association; they require signatures of 250 members of the Association and are due on or before March 15.

Nine Nominees for the Nominating Committee

Nine nominees are standing for three vacancies on the 1975 National Nominating Committee of the Alumni Association — the group, representing all the Association's nine geographic districts, who will nominate the slate for the 1976 national election.

As of February 1, the Nominating Committee slate is the only contested part of the 1975 national election *(see above)* — perhaps the membership's only chance to influence the choice of 1976-77 officers of the Association.

The nominees, each proposed by an M.I.T. club in the district concerned, are listed below; one is to be chosen for each district on the 1975 national ballot in April.

District 5

Russell F. Hodges, '43, of Bryn-Mawr, Pa. Mr. Hodges, who graduated from M.I.T. in mechanical engineering, is Account Executive with Yarnell-Biddle Co., investments, Philadelphia.

Edward F. Murphy, Jr., '41, of Pittsburgh. Mr. Murphy is Regional Manager for Linde Air Products Division of Union Carbide Corp.; his undergraduate degree is in management.

Mary Frances Wagley, '47, Headmistress of St. Paul's School for Girls, Brooklandville, Md. Dr. Wagley studied chemistry at M.I.T. and has taught at Goucher College, Johns Hopkins University, and Smith College; she is a member of the M.I.T. Corporation.

District 6

Charles E. Bossi, '42, of Kettering, Ohio. A management graduate, Mr. Bossi is owner of C B Development Co., real estate construction and leasing, Dayton.

John T. Shutack, '43, of Hinsdale, Ill. Mr. Shutack is Senior Vice President in the Chicago office of the management firm of Booz, Allen and Hamilton; his degree is in management.

Sheldon G. Thorpe, '52, of Cleveland. Mr. Thorpe is Assistant to the President of Youngstown Steel Door Co. He studied management at the Institute, and he has held technical management positions in a number of midwestern companies.

District 7

Donald E. Burke, '46, of St. Petersburg. A graduate in aeronautics and astronautics and in management, Mr. Burke is with the Florida Municipal Bond Department of Reynolds Securities, Inc., St. Petersburg.

George H. Wayne, '48, of Miami, whose M.I.T. degrees (S.B. and S.M.) are in electrical engineering. Mr. Wayne was founder and — until its acquisition by Itek Corp. — President of Wayne-George Corp., Newton, Mass.; he is now a Director of Dynamics Research Corp., Wilmington, Mass.

Gordon T. Yamada, S.M. '62, of Arlington, Va. Mr. Yamada was a Sloan Fellow at M.I.T.; after a management career in the Department of Defense, he is now associated with the General Services Administration in Washington. □

Adjunct Professor: To Bring "Doing" to M.I.T.

A new rank of Adjunct Professor, intended for people of senior experience who will work part-time on M.I.T. activities which require "knowledge and skills which do not normally exist on the faculty and which cannot be taught in-house," has been approved by the faculty for a three-year trial.

Reporting for a study committee, William L. Porter, Dean of the School of Architecture and Planning, recalled for the faculty at its November meeting "the M.I.T. tradition of combining 'thinking' and 'doing' in its educational activities" and "the belief held widely at M.I.T. that such a combination is the way to educate." He said the new rank "would provide an important means to couple teaching and research programs to the issues and to the institutions of our society, . . . a type of interaction with the outside world different from that now possible within existing faculty ranks."

Though support was general, several members of the faculty questioned or opposed the plan during a 45-minute debate. Some wondered if the new rank was needed, since categories such as Visiting Professor already existed (the Adjunct Professor is different, argued Dean Porter; he would be recognized as a part-time teacher with a loyalty divided between M.I.T. and some organization outside it.) Others said they feared the new rank might produce conflicts of interest (particularly with respect to patents and research sponsorship), threaten the tenure and promotion system, prove costly in a period of budget restrictions, lessen academic professionalism, and reduce the chances of junior faculty for advancement.

During the trial period, no more than 25 Adjunct Professors may be serving at any one time, and in any department, they may not number more than 5 per cent of the faculty in that department. □

Computers and People in Research: Toward a New Partnership of Ideas and Techniques

A laboratory without a computer? Unthinkable, these days.

But what about a laboratory peopled entirely by computers? Equally unthinkable, thinks Paul F. Doering, '58, of the Eastman Kodak Co.'s Research Laboratories in Rochester, N.Y. He dismisses that futuristic vision in favor of a different scenario for a subtler but more significant change caused by the computer's growing inroads in research and development.

In a tutorial presentation to the American Chemical Society last fall, Mr. Doering cited two reasons for his confidence that the computer will never replace the research engineer:

— Computers have never achieved quite the heights which their proponents have predicted for them. Remember computerized language translation, a dream (the "fad of the 1960s," said Mr. Doering) into which was poured millions of dollars of research money? There turned out to be an intractable problem: the machine's inability to cope with the idiom, he said, recalling the story of the computer asked to translate "out of sight, out of mind"; its response: "invisible lunatic."

— Computers need programs. "We cannot submit our problem to the computer without first specifying in painfully minute detail what steps the computer must perform en route to a correct solution," and the fact is that a computer will "execute a bad program just as loyally as a good one." So it requires the presence of scientists and engineers — and it imposes on them an "objective problem analysis . . . absent in some of our casual, subjective formulations of human-run experiments," thinks Mr. Doering.

Herein, too, lies what Mr. Doering thinks is the computer's thrust for "profound change" in the practice of research and development. We try to find common elements in all our computerized problems in order to reduce our programming effort. And this search for commonality leads us toward "a new comprehension — a scientific urbanity, if you will — helping us to formulate relationships to which our earlier, more

What does an engineer expect of a human laboratory assistant? That he'll run an experiment without undue supervision and record and analyze the data accurately. You can expect exactly the same thing of a computer, says Paul F. Doering, '58, of Eastman Kodak Co. But there's a subtle difference, and therein lies the reason that the computer will never displace the engineer in research and development.

parochial viewpoints may have blinded us.

"We tend to become people of ideas instead of people of techniques," he said — a change which future historians may regard as "the greatest contribution that computers will have made to the laboratory." □

Potentially Great Racers Made of Cardboard and Paper Clips

The stands were packed. Photographers jockeyed for a shot of the photo finish. Shades of Andy Granatelli's ball bearing! Was this the Indy 500? The Grand Prix, perhaps? Close, but no cigar. The scene was Room 3-270, where the 2.70 design contest — "The Potentially Great Race" — was being held.

Each semester of 2.70 (Introduction to Design, taught last term by Robert W. Mann, '50, Uncas Whitaker Professor of Biomedical Engineering, Associate Professor Igor Paul, '60, and Assistant Professor Woodie C. Flowers, Ph.D. '73) includes an innovative design and construction contest. Problems have ranged from a water-bearing waiter to a marble-carrying pulley, designed by students and built with kits comprised of such common artifacts as throat lozenges and mouse traps.

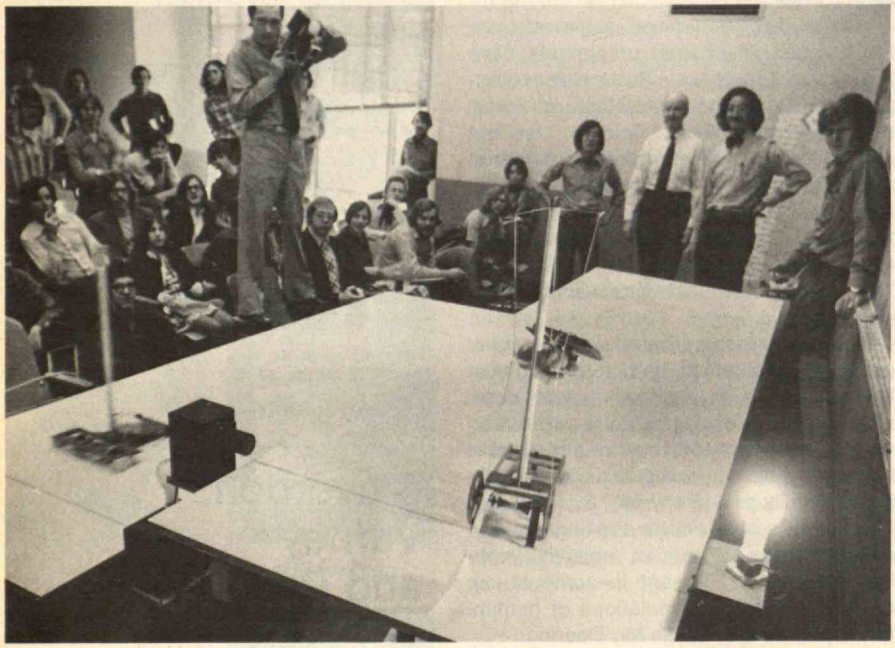
This year's instructions described the goal as "a device which travels down a given track (3 × 10 ft.), turns on a light bulb by interrupting a light beam, reverses direction, and travels back across the 'start' line as quickly as possible." To build their entries, students had small sheets of Masonite, celluloid, and paper; tubing of cardboard and polyflow; welding and steel rods; string; Lycra thread; wooden strips and dowels; rubber bands; paper clips; caster wheels; note cards; one pound of sand; plexiglass; and a pencil. Glue and other adhesives could only be used for bonding and nonfunctional decoration. The rules stipulated that the energy used by the device had to come solely from a change in the altitude of its center of gravity and that the device's dimensions had to be contained by a two-foot cube measured from the device's base.

A month and a half after the class received the assignment and kits, the breathless audience was waiting. There was an early favorite: a gleaming orange racer with a color-coordinated flag atop a pole; the flag dropped down to block the light beam so that the racer would be saved the time needed to cover the length of the pole. But the flag did not operate during the semifinals; nevertheless, the creator, Paul Robershotte, '76, retained the record time of 6.2 seconds.

Dependability, coupled with speed, was the final judge as the two winning racers matched turns of the wheel, hitting the light beam within milliseconds of each other while the cries of their fans urged them on. At the finish, the Polaroid photograph proved Lee Ho, '76, to be the winner, clocked at just 7.6 sec.

And the prize for his hard work? A new design book which had just arrived the previous day in the mail.

What does all this have to do with teaching would-be engineers how to design serious, useful products? Just this, said Professor Flowers, explaining his idea to a group of high school teachers visiting M.I.T. in the fall: All the lectures and all the handbooks in the world won't give a student confidence to use what they can tell him with imagination and wisdom. If simple — even hilarious, but serious — contests can help students over this ultimate psychological hurdle, that may be the most important contribution M.I.T. can make; after all, a good student can read books and use computers on his own, any time. □



How do students learn engineering design? That may not be the crucial question, thinks Professor Woodie C. Flowers, Ph.D. '73; the real problem may be to give students the confidence they need to innovate creatively. Hence the annual 2.70 design contests. Last fall the problem was to build (from a given packet of materials) a machine to run down a track, interrupt a light beam, and run back again to the starting line as quickly as possible. In this picture a "potentially great racer" entered in the final competition has reached its first destination and is ready for its return trip; the photographer is Professor Igor Paul, '60, and Professor Robert W. Mann, '50, is standing with Professor Flowers behind the "finish" line.

Tuition to $3,700 Under Pressure of Inflation

Tuition was sure to rise; it was only a question of how much, and when the ascent would be announced.

Uncertainties were resolved early in December: Effective with the Summer Session in 1975, tuition will be $3,700 for an academic year of two terms. It is an increase of $350 over the $3,350 tuition for 1974-75.

Though annual tuition increases have come to be expected at the Institute, Paul E. Gray, '54, Chancellor, said in announcing the new rate that M.I.T. tuition — though it grew faster than did the consumer price index early in the past decade — was in fact falling behind the general level of inflation during the past two years. And in the last ten years, he said, tuition "has declined slightly as a fraction of median family income and as a fraction of the average starting salary of M.I.T. graduates."

Inflation is obviously the villain behind the latest increase. "In the face of rapidly rising costs of materials and services," Dr. Gray said, "M.I.T. had no responsible alternative."

"All major private universities are confronted with the same fiscal reality, and others are finding tuition increases essential to maintain their quality and solvency over the long run. Despite next year's increase, however, M.I.T.'s tuition will continue to bear only the same percentage of total university costs that it has over the past decade."

Next year, at $3,700, tuition income will account for about 39 per cent of M.I.T.'s total expenses — exclusive of direct expenses for sponsored research. In 1962-63, when tuition was $1,700, the percentage was 40. □

"Rates Will Not Be Going Up"

. . . an unusual headline these days — and in sharp contrast to the one immediately above it in *The Tech* (see above). Dormitory and commons meals rates, defying inflationary pressures, would not go up in the second term.

"As we see it now," Arthur Beals, Associate Director of Housing and Food Services, told *The Tech,* "our guesses were good enough to rule out the necessity of housing rate increases. . . . Our heat rate estimates were right on the nose. Electricity was somewhat higher than we had anticipated, but with everything considered we came out about even." □

45,000 Books for $53,000

Some 22,000 people came to the Sala de Puerto Rico on December 4, 5, 6, and 7, and they brought some 45,000 M.I.T. Press books at discounts from list prices ranging from 50 to 90 per cent. Proceeds totalled some $53,000, Anne Sayre, Publicity Manager of the Press, told The Tech. *It was the largest version yet of a sale which is fast becoming a pre-holiday tradition in Cambridge.*

The Press, explained Ms. Sayre, was looking for "ready cash" and was "basically trying to get rid of all unsalable stock." The books in the Sala included damaged and overstock volumes. □

See the World With the Debate Society

Resolved: That the M.I.T. Debate Society Opened Its Season With Its Best Performance in Five Years.

Last year, the Debate Society finished first in New England and 20th in the country. But this year, thinks Jack Segal, '76, Society President, team prospects are even better. That's because of the growing popularity of debating, he told Margaret Brandeau, '77, of *The Tech*; four top upperclassmen are back from last year, and several good freshmen have joined the ranks.

The Society started its season during the first weekend in October (4-6), by sponsoring the M.I.T. Invitational Debate Tournament — the first major competition on the 1974 collegiate debate circuit. Although M.I.T., as the host school, could not participate, the debaters had a chance to watch their foremost challengers in action; the University of North Carolina team proved to be the toughest, winning with an undefeated tournament record.

Since then, M.I.T.'s top team, consisting of Larry Summers, '74, and Mr. Segal, has won two of six tournaments with fields averaging 60 teams. The wins were at the Tarheel Invitational at the University of North Carolina (October 25-27) and at Boston University (November 8-10); Summers was named third-best speaker at Tarheel.

At the Catholic University Round Robin Debate Tournament, Washington, D.C. (November 25-27), to which the country's top eleven forensic teams were invited, Summers and Segal were second, losing 8-2 to Georgetown's 9-1. Two days later at the Georgetown Invitational, the same M.I.T. team was forced out in the semifinals, finishing third out of 120; however, Summers was named fifth-best speaker at both tournaments.

Providing strong second- and third-team support during the Alan S. Rapaporte Memorial Tournament at Brandeis University, Mark Sherman, '77, and Richard Steinberg, '77, took second place and Tom Mattison, '78, and Jeff Lillien, '78, finished ninth — the first M.I.T. freshman team in the last two years to compete in the final round of a varsity tournament. And to supplement the win at Boston University, Messrs. Sherman and Steinberg reached the quarterfinals, only to be "closed-out" by Messrs. Summers and Segal (when two teams from the same school are paired, there is no debate and the lower-ranked team retires from the tournament). During Christmas vacation, Messrs. Summers and Segal competed in two West Coast tournaments. Their fifth-place finishes made their cumulative record 70-14.

At M.I.T., as Mr. Segal told Ms. Brandeau, debating is not a topic to be treated lightly. After devoting approximately 30 hours each week, debaters come to think of their avocation as "a quasi-social activity. To us it's a sport . . . a team competition. We get as much sporting competition out of it as other people do playing basketball or hockey."

Funded through the Finance Board of the Association of Student Activities, the Debate Society attends about 20 tournaments each year at colleges throughout the United States. So a good debater has a chance literally to tour the country. Perhaps their slogan should be: "Join the Debate Society and See the World." □

Caution: These Toys May Be Hazardous To Your Health

Christmas may be two months past, but its joys and presents remain. Even with all the precautions that parents take in selecting toys, some of these are potentially harmful to curious tots who bang and pry at their playthings.

Concerned that dangerous toys banned by the U.S. Consumer Product Safety Commission might still be on sale, 44 volunteers, all pledges of three M.I.T. fraternities — Delta Tau Delta, Delta Upsilon, and Phi Gamma Delta — canvassed 150 stores in Boston, Cambridge, Revere, Natick, and Quincy as the Christmas shopping season opened. They found seven toys branded as dangerous by their preliminary findings still on the shelves of several stores.

Edward A. Michelson, '78, from D.T.D., who headed this survey, reported that the offending stores, most of which were suburban rather than urban, sold banned toys which ranged from the "party favor" type — horns and squealers — containing easily breakable parts, to toys with plastic or metal squeakers and whistles whose small noisemakers could easily be swallowed. All but one store acted promptly to remove the items when shown listings in a 90-page booklet published by the Commission.

Only "three or four stores wouldn't let us in," said Mr. Michelson. But there were other frustrations. Craig Wallach, '78, of D.U. became interested in the project because his sister was injured while playing with lawn "jarts," a type of dart game; one of the "jarts" hit her. When approached, the manufacturer did not remove the game from stores; instead, the product was switched from toy to sporting goods sections, leaving it accessible to unsuspecting adults.

Mr. Michelson, an experienced hand in consumerism (he led a similar project in high school), believes that 1974 was the last year for such a project due to new laws compelling toy manufacturers to recall toys with dangerous parts. Unfortunately, some small stores have a low turnover — hence the availability of stock which predates enforcement action based on the Federal Hazardous Substances Act of 1972.

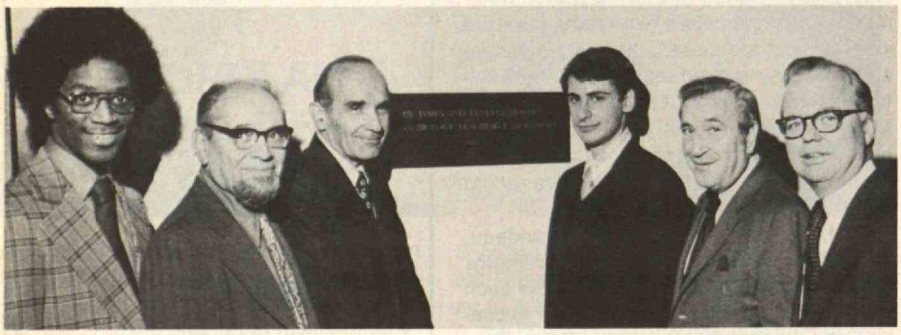
But the survey proved to be so successful that a Tri-Fraternity Freshman Association was formed by the three participating pledge classes. Composed of two representatives from each fraternity, the Association will continue to act as a social activities group in order to aid the public as well as themselves. They expect a $500 grant from the Commission to be paid upon receipt of their report on 1974 activities. □

Holden Laboratory for Human Biology

The first (preclinical) part of the curriculum of the Harvard-M.I.T. Program in Health Sciences and Technology is called human biology — anatomy, pathology, endocrinology, hematology, gastroenterology, and a series of more specialized topics. Some are given at M.I.T., some at Harvard Medical School.

Now a $262,000 grant of the James and Lynelle Holden Fund has made possible a new home for the courses in human biology at M.I.T. — the Holden Human Biology Teaching Laboratory on the second floor of Building 4. More than a laboratory: there are, as well, seminar-conference rooms, library and reading areas, and a student lounge. Eventually there will be three multi-purpose pathology laboratories, two physiology laboratories, an audio-visual self-teaching area, and additional seminar rooms.

The new facilities are described as "a fundamental first step" for the Harvard-M.I.T. program; President Jerome B. Wiesner says they will give "an enormous boost . . . to the joint Harvard-M.I.T. enterprise," and he spoke of its increasing response to "the national demand for education, research, and development in the health sciences and technology." □



New M.I.T. quarters for the four-year-old Harvard-M.I.T. Program in Health Sciences and Technology are centered in the James and Lynelle Holden Human Biology Teaching Laboratory. At the dedication on November 14 were Kenneth R. Bridges, a student in the Program; Walter A. Rosenblith, Provost of M.I.T.; Irving M. London, Director of the Program; and Richard J. Cohen, a student.

The World in Microcosm: What Hunger Feels Like

You've just paid $2 to experience the present world food situation. As you go through the line, you are handed a bowl of rice and some tea. But you see your neighbor behind you loading his tray with a steak dinner, complete with green vegetables and rice. What do you do?

Steven Murphy, Associate Chaplain of the M.I.T. Catholic Community, feels that the "Hunger Banquet" on November 21 really "hit people over the head."

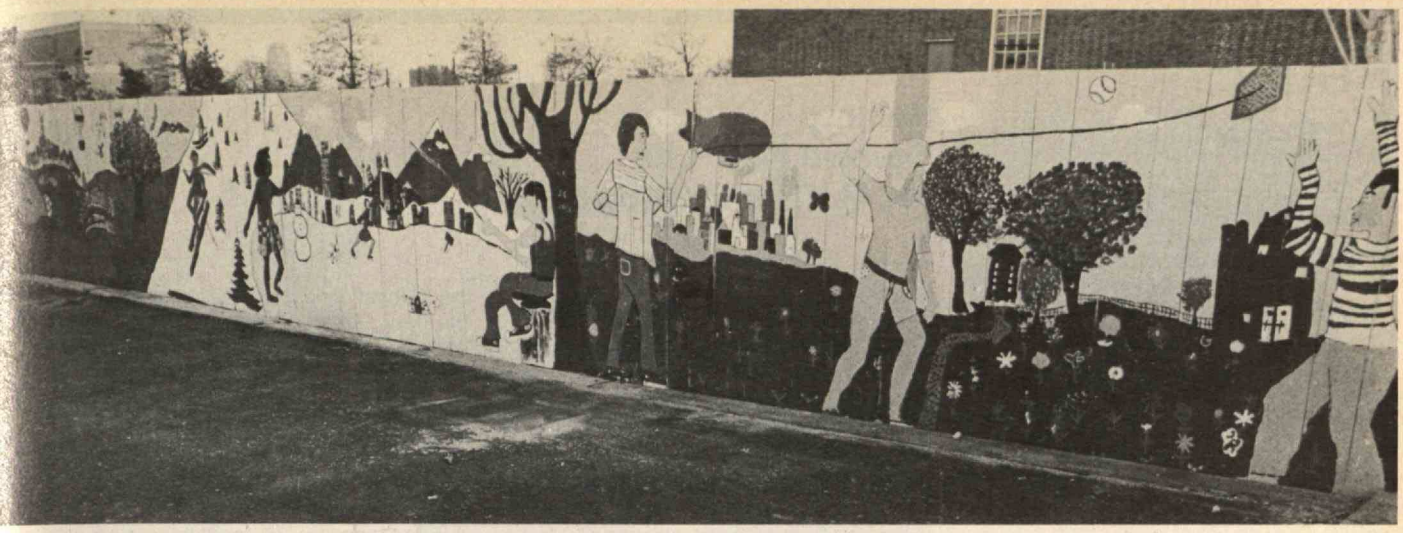
The idea was to "reflect the nutritional inequities of consumption and distribution of food in the world," he says. It worked this way: only one of every four people passing through the line in the Lobdell Room received a complete dinner; the other three ate rice and tea.

Mr. Murphy thinks that a microcosm of world famine unfolded, that very few people had really understood the impact of world food scarcity until they felt it this way. Several people pointed out that the banquet didn't accurately reflect the world food situation: Nobody went hungry. Some of those who received steak dinners offered to share them with poorer-fed neighbors; but a number of the rice-and-tea diners were too proud to accept the kind offer. (Only one person demanded his money back — a reaction which Mr. Murphy expected and believes is justified.)

Reservations for the banquet, organized by an *Ad Hoc* Committee at M.I.T. Concerned about World Hunger, reached the maximum limit of 150; lots of people were turned away.

It was all part of a national program sponsored by Oxfam-America, the Oxford Committee for Famine Relief. M.I.T.'s banquet netted $300, and there were sizeable sums from similar activities on other Boston campuses.

In a parallel M.I.T. activity, the *Ad Hoc* Committee brought together Nevin S. Scrimshaw, Head of the Department of Nutrition and Food Science; Peter Hakim, Visiting Lecturer with M.I.T.'s International Nutrition Planning Program; Anthony Lewis, National Correspondent of the New York Times; Ngo Vinh Long, Director of the Vietnamese Resource Center; and Jay W. Forrester, Germeshausen Professor in the Sloan School of Management, for a discussion of alternative responses to the world food crisis. Professor Forrester, whose comments on the nation's hard alternatives were by far the most controversial contribution to the discussion, agreed that the event was at least "remarkably successful in getting people to stand up and argue." It's a process which Mr. Murphy thinks a good start toward understanding and perhaps solution. □



Decorated by a 70-foot mural (above), the "people's park" in Allston is a labor of love and the product of "sweat equity." Residents — adults and children alike — laid cobblestones in aesthetic patterns (far left), vied for the honor of signing their names in cement by designing the best mosaics (center), and virtually created the playground themselves with the assistance of Nick Elton (left), an M.I.T. graduate student in architecture, who found the project through M.I.T.'s Community Projects Laboratory. (Photos: Roger Goldstein, '74, from *The Tech*.)

"People's Park": Unconventional — and Built Unconventionally

When is a playgound *really* a playground? When it's a product of the people who will be using it — not necessarily an arrangement of concrete and steel, but a combination of these with recycled bricks and tires, contributed materials, and "sweat equity" provided by the residents themselves.

On North Harvard St., Allston, such a project, to be completed this spring, is taking shape under the guidance of P. Nicholas Elton, an M.I.T. graduate student in architecture. Although Mr. Elton designed the basic layout of the park, the residents did most of the planning — keeping in mind their own needs and the needs of future residents.

The result: what Mr. Elton says will be "a conventional playground built unconventionally," containing an area for the elderly located near the entrance, two play areas — one for tots and the other for older children, a bike path winding its way through the park, a basketball court constructed with M.I.T.-negotiated asphalt, and a wood gazebo for protection against sun and rain.

Almost two years ago, the residents of the Charlesview Housing Project decided they needed a "people's park," but they had no money to build one. So they raised $2,000 through cake sales and barbecues, formed the North Harvard Neighborhood Council, Inc., and presented Harvard University with a 185-signature petition requesting permission to rent an unused ¾-acre parcel of land owned by Harvard. Harvard liked the idea and gave the Council a free five-year lease.

That was when the Council sought the aid of M.I.T.'s Community Projects Laboratory (C.P.L.) — an organization formed in 1968 to provide field experience for students and to contribute to the community and its residents. [Since then, the spin-off Architectural Assistance Program (A.A.P.) has been established to offer students short-term employment for token pay or long-range projects, like the park, for academic credit.]

Nick Elton, who was participating in the program, turned out to be an excellent candidate for the job, having had experience scrounging and saving while he was in Brazil for the Peace Corps. With funds from the Allston-Brighton Area Planning Action Council (A.C.A.P.) and the C.P.L., Mr. Elton and the residents were able to hire 30 students from the Neighborhood Youth Corps (N.Y.C.) and buy a few materials. Working every day during the summer and every weekend in the fall, they saw the park slowly but surely begin to materialize.

A 70-foot fence constructed from wood donated by WGBH-TV has become a giant, children-made mural coordinated by students from the Massachusetts College of Art; a manufacturer of dust collectors has given a piece of sheet steel which has become a 22-foot curved slide. Among other contributions have been 75 trees from the Arnold Arboretum Society, and telephone poles from the telephone company. Telephone poles? When the time came to build the basketball court, explained Mr. Elton, "we had to use land which was originally marsh. So we lined the court with telephone poles, some from the telephone company and others which we ourselves had found."

When the park is finished, how will the area be protected and maintained? As Mr. Elton told Phyllis Coons of the *Boston Globe*, "the best protection will be the people who live there. They built it." □

Sailing: Toward New Life for M.I.T.'s First Sport

Bowline . . . battens . . . jibe . . . clove hitch . . . sheet . . . lanyard . . . chock . . . jib . . .

Hundreds of students, perhaps beginning with Nathanael Herreshoff, '70, who was a member of the third class to enter the Institute, have come to M.I.T. knowing nearly all there is to know about this very special vocabulary and the experiences it represents. But thousands have been introduced to sailing on the Charles River, attending a "shore school" to memorize knots and rules of the road, passing swimming tests, and qualifying as "crew" and finally as full-fledged members of the Nautical Association. It is M.I.T.'s largest single extracurricular activity and probably its most successful intercollegiate sport.

The early history of sailing at the Institute is not so clear. A Yacht Club was organized in 1894, and Technique records that President Francis A. Walker, Professor George A. Osborne (navigation and astronomy), George Owen, '94 (naval architecture), and Professor Cecil H. Peabody, '77 (mechanical engineering), were among its Honorary Members. Mr. Herreshoff was lured back to his family boatyard after only a year at the Institute; and the Institute career of another sailor — Olin J. Stephens, II, '30, designer of five America's Cup defenders — was equally brief.

The fog of uncertainty dissipates in 1935, the year of the founding of the M.I.T. Nautical Association and the construction of the first Tech Dinghy (the design was by George Owen, who was by now Professor of Naval Architecture, the construction by the Herreshoff Boatyard in Bristol, R.I.). By 1936 Henry A. Morss, '93, Assistant Treasurer, and Professor Erwin H. Schell, '12, were successfully raising funds for a sailing pavilion, and it all came together by the end of that year, 38 years ago.

M.I.T.'s reputation in sailing was secure almost immediately. The Tech Dinghy set the standard for North American collegiate sailing and racing; and during the first 25 years of the North American Intercollegiate Racing Championship, M.I.T. won the Henry A. Morss Bowl 11 times.

Seven Members of the Hall of Fame

Among M.I.T.'s sailing alumni — including 17 National High Point Skippers — are George Warren Smith, '26, the current National Bullseye Champion (*see Oct./Nov., 1974, p. 135*), and Pierre S. duPont, '33, and Daniel D. Strohmeier, '34, participants in the Newport-to-Bermuda race. Sumner A. ("Huey") Long, '47, won that same race last June and adds its trophy to others, including the Transatlantic and the Transpacific (*see Oct./Nov., 1974, p. 143*). Alain J. deBerc, '55, was still an undergraduate when, as a member of the National United States Sailing Team, he was awarded the Sir Thomas Lipton Memorial Cup.

The Olympics, perhaps the most competitive sailing event of all, has seen four M.I.T. competitors, two of them medalists: C. Eric Olsen, Jr., '39 (recently elected, with Mr. deBerc and seven other M.I.T. graduates, to the Hall of Fame of the Intercollegiate Yacht Racing Association of North America), Edward A. Melaika, '53, Ralph L. Evans, Jr., '48 (silver medal), and John Marvin, '49 (bronze medal).

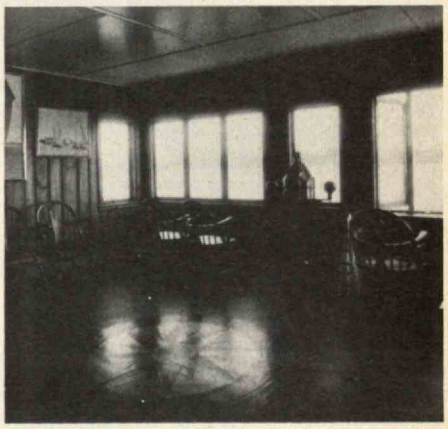
More recently, Terry L. Cronberg, '66, another Hall of Famer, and Stephen J. Cucchiaro, '74, a 1973 All-American, have won the Prince of Wales Trophy, one of the five North American yachting championships. And women are taking the helm with varsity status, already boasting two champions: Maria Bozzuto, '73, and Shelly Bernstein, '74, winners of the 1973 National Women's Sailing Championship.

None of this could have happened without Walter C. Wood, '17, who returned to the Institute in 1937 to be Sailing Master — a post he held until retirement 27 years later. Mr. Wood founded the Hall of Fame of the Intercollegiate Yacht Racing Association (and was among the first elected to membership). He stimulated intercollegiate sailing throughout the U.S. and he was the best "salesman" M.I.T.'s sailing ever had.

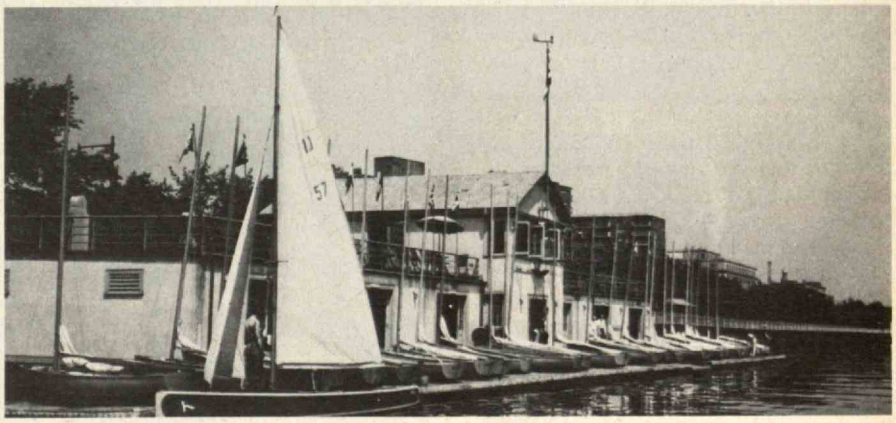
From a beginning membership of 500, the Nautical Association grew quickly to something over 1,000; more than 200 sailors are on the River during the course of a good day in fall and spring, and sailing is the most popular elective offered by the Athletic Department. Perhaps 15,000 people have learned the challenge and pleasure of sailing at M.I.T.

After 38 years some improvements are now in order. The first generation of Tech Dinghies gave way to a new design — fiberglass — in 1953, and today's "most pressing" need is for a third-generation fleet, says Mr. Smith, who is leading a campaign within the 1975 Alumni Fund to raise $211,800 for sailing at M.I.T.; ultimately, a fleet of 55 dinghies and larks is planned. Also needed: improvements to the sailing pavilion for the shore school, better shops and better storage — an $80,000 addition and refurbishing project.

Alumni interested in the plans should write to the Fund or to George Warren Smith, Box 506, Pigeon Cove, Mass., 01966. □



Sailing scenes, old and new: the Shamrock (top left), named after Sir Thomas Lipton's own boat, is a far cry from the dinghies Jack Wood, 17, and President Karl T. Compton (above) used to sail; competition is fierce and women provide an ample share of it (top right); as a result of the fund-raising campaign, the Sailing Pavilion (right) should soon be better than ever. (Photos: M.I.T. Nautical Association, M.I.T. Historical Collections, M.I.T. Design Services.)



Shown in action: a water polo goalie (top) attempts to make a save; a freshman soccer player (above left) does some fancy footwork; and sailing enthusiasts (above right) keep their sails full. In the New Englands, harrier Al Carlson, '75, (right) contributed toward M.I.T.'s third-best finish in Division III. (Photos: Ed McCabe, '75, from The Tech, *M.I.T. Athletic Department, M.I.T. Design Services.)*

Fall Sports: More in the Future than the Present

Although the fall 1974 sports record appeared dismal — 19 wins, some 21 losses, and 3 ties — hope for the future can be drawn from some superb, though scoreless, playing.

Heading the list was the cross-country team which sported a 9-2 record, the second best in M.I.T.'s history. Losing only to Brandeis and Worcester Polytech, the team was led by Frank Richardson, '77, who won five of the six regular-season races and posted the fastest time — 24:30 — run by an M.I.T. harrier over the Franklin Park (Mass.) five-mile course. He also placed seventh in the Eastern Small Colleges Championships, 19th in the New Englands, and 30th in the National Collegiate Division III Title run.

The golf team with a 3-1-1 record displayed an overall talent which should become more evident in the spring. With no outstanding low scorer, the team's best victory (5-2) was over Boston College, a perennial New England golf power.

With impressive victories over four opponents and losing decisively to only Harvard and Yale Universities, the water polo team's 4-8 record was a vast improvement over last season's 1-11 showing. Although most of the team will be lost at Commencement time, Steve Melknikoff, '78, and goalie Steve Oblath, '77, both of whom were starters this year, are expected to be the team's future mainstays.

In soccer, M.I.T.'s team was plagued with injuries to key forwards, resulting in a disappointing 1-10-2 season. Captain Ray Marotta, '75, led the team with five season goals while Charlie Sommer, '76, allowed only one goal in six games, four of which were 1-0 losses. Captain Marotta and Greg Hunter, '76, were selected for the Greater Boston All-Star Team with fullback Hunter also winning All-New England honors in the college division.

For the men's and women's sailing teams, this fall was not one of their best seasons, the men winning only two major regattas and the women, in a state of reorganization, placing fourth in four minor regattas. The annual Jack Wood and Staake Trophy regattas were won by "A" division skipper, Chuck Tucker, '76, and crew, Chuck Johnson, '76, and "B" division skippers, Paul Erb, '76, and Bill Critch, '77, and crew, Steve Gourley, '77. □

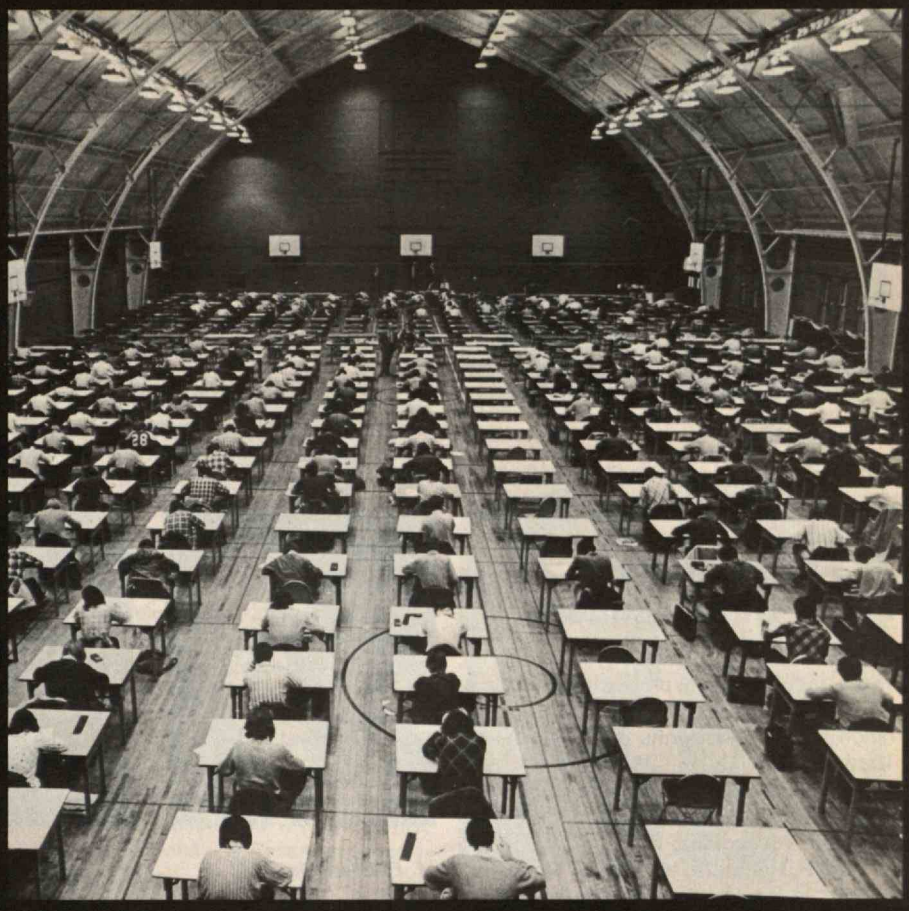
Running 255 Miles in One Day

For 24 hours beginning at noon on Friday, November 29, ten members of the varsity cross-country team took turns running one mile on the track in Rockwell Cage. By Saturday noon, 24 hours later, they had covered 255.15 mi. — a heart-breaking 1.65 mi. less than the Massachusetts 24-hour marathon record of 256.8 mi., which was their goal.

There was little food and almost no sleep. Every mile covered in the first 14 hours of the event was done in less than six minutes; the best was run by Alfred Carlson, '75, in 4:56. But by Saturday morning the average was a good deal longer, and overall each mile should have been run just 2.6 sec. faster if the team was to break the state record. □

The Gallery

Aspects of the Cambridge scene this winter (clockwise, beginning at the right):
— You thought final examinations were a thing of the past at M.I.T.? Look at how students finished the first term in the traditional way as the Christmas holidays approached; the scene is du Pont Gym.
— The Cambridge children are in the newly-decorated quarters of Tutoring Plus at 183 Harvard Street; they're shown with Paul E. Fallon, '78, who organized his fraternity brothers at Phi Delta Theta to face-lift Tutoring Plus' threadbare rooms.
— A rare warm day in winter found Paul E. Gray, '54, Chancellor, in a moment of quiet — reviewing notes before a speaking appearance.
— The Charles Stark Draper Laboratory takes the plunge: four principals at the groundbreaking for Draper's new quarters in Technology Square.
— David Epstein; Conductor of the M.I.T. Symphony Orchestra, took the podium at the Boston Symphony Youth Concert for a new work commissioned of himself and his wife by the Youth Concerts; the narrator is Janet Bookspan.



People

The Corporation Picks Three Leaders

Three industrial and professional leaders were elected members of the M.I.T. Corporation for five-year terms on December 6. They are:

— **Maurice F. Granville, Jr.,** S.M. '39, Chairman of the Board and Chief Executive Officer of Texaco, Inc.

— **Paul F. Hellmuth,** '47, Senior Managing Partner in the law firm of Hale and Dorr, Boston.

— **Richard L. Terrell,** Vice Chairman of the Board of General Motors Corp.

All three will meet with the Corporation for the first time early in March.

Mr. Granville studied at the University of Texas before entering the Institute, and he joined Texaco upon completing his M.I.T. degree in chemical engineering. He became President of Texaco's Petrochemical Department in 1960, Vice President for Planning in 1967, and President in 1970. Meanwhile, he has served on the Corporation Visiting Committee for Chemical Engineering and on the National Sponsoring Committee for the new chemical engineering building now under construction, and he has been active in the M.I.T. Alumni Center of New York.

Mr. Hellmuth, who graduated from the University of Notre Dame, studied in the Sloan School of Management at M.I.T. in 1947 while working for the LL.B. degree at Harvard. He joined Hale and Dorr upon completing his legal studies, and since then he has risen to leadership in that firm while serving many nonprofit educational, medical, and social organizations in a volunteer leadership capacity.

Mr. Terrell is the first member of the Program for Senior Executives in the Sloan School of Management to be elected to the Corporation; he attended the Program in 1958, just before he became Vice President of General Motors. Since then he has worked in top management positions in several General Motors groups, becoming a G.M. Director in 1972. □

M. F. Granville

P. F. Hellmuth

R. L. Terrell

The Persevering Inventor of Power Steering Recalls His Struggles with $1 Million Gift

Francis Wright Davis knew all about power steering for automobiles and trucks in the 1920s, but he found Detroit a bit reluctant. Indeed, despite his advocacy, U.S. automakers remained skeptical for nearly 30 years. Only after World War II, when power steering finally became a commonplace feature of American automobiles, could Dr. Davis consider his battle won.

Now he has celebrated it all by giving M.I.T. $1 million in gift and pledge to establish the Francis Wright Davis Professorship.

The announcement was made at a luncheon early in the winter, where Dr. Davis (he lives in Belmont and Nantucket, Mass.) was introduced by Robert H. Rines, '42, a distinguished patent lawyer who is Dean of the Law School at Franklin Pierce College and Lecturer in the M.I.T. Department of Electrical Engineering. Along with Institute dignitaries at the luncheon were a group of Dean Rines' students whose special interest is inventions and innovations — subjects that have concerned Dr. Davis all of his professional life. They learned from Dr. Davis that the one overriding attribute needed by the independent inventor is perseverance. His own experience with power steering he said, bears that out.

In 1925, Dr. Davis had power steering on his own car, a 1921 Pierce-Arrow runabout, but it was not unitl 1951 that an American rolled off a production line equipped with power steering.

In between were years of dealing with cautious automotive industry engineers and bitter disappointments as the depression cancelled one company's plans to produce cars with power steering, and the start of World War II caused the total suspension of all production of civilian vehicles.

Dr. Davis joined the Pierce-Arrow Co. in Buffalo, N.Y. in 1910. Twelve years later he was Chief Engineer of the Company's Truck Division. He spent a year in England and France during World War I for Pierce-Arrow, which was supplying trucks to the Allied Forces; then in 1922 he left the Company and established himself as a consulting engineer in the motor truck field. But he didn't neglect the passenger car.

In 1924 he patented the Davis Steering Gear Coupling and sold the device to Pierce-Arrow owners. The invention involved a rubber coupling between the lower and upper parts of the metal steering column that reduced the jiggle in the steering wheel and prevented engine noise from being transmitted along the steering column to the steering wheel. Car owners liked the device but asked for more, Dr. Davis said.

"When they tried to park those big

It was nearly 30 years after he invented it that power steering first appeared on a commercially built automobile in the U.S. And the lesson in entrepreneurship and perseverance which Francis Wright Davis learned in the 1920s, 1930s, and 1940s is just as important today, he told a group of students at the luncheon where this picture was made, when Dr. Davis announced a $1-million gift to M.I.T. for a professorship which will be named in his honor. In the picture are (left to right) Robert H. Rines, '42, Lecturer in the Department of Electrical Engineering; James R. Killian, Jr., '26, Honorary Chairman of the M.I.T. Corporation, Dr. Davis, and Robert A. Alberty, Dean of the School of Science. (Photo: Richard Reihl, '77 from The Tech). □

Pierce-Arrows in small spaces, they had to work very hard on the steering wheel — especially women drivers," he said.

"This problem stimulated me to conceive a solution in using some of the power from the mechanism and the engine to assist in turning the steering wheel.

"And that started me thinking about power steering for autos and trucks." □

Nine Faculty Changes

New appointments and promotions for nine members of the faculty were announced early this winter:

— **Ann F. Friedlaender,** Ph.D. '64, formerly Professor of Economics at Boston College, now holds a joint appointment as Professor of Civil Engineering and of Economics at the Institute. She is a specialist in public and urban finance, a member of the Board of Editors of the *American Economic Review,* the *Quarterly Journal of Economics,* and the *Public Finance Quarterly,* and she sits on the Committee on Urban Public Economics. Dr. Friedlaender was a member of the Brookings Institute from 1966 to 1970.

— **Sandra C. Howell,** formerly Research Associate in the Department of Architecture, is now Associate Professor of Behavioral Science in that Department. She came to M.I.T. in 1973 from the Florence Heller Graduate School for Advanced Studies in Social Welfare at Brandeis University, and she has continued at M.I.T. to work on architectural problems related to human aging, an aspect of the newly developing field of environmental psychology. She holds degrees in public health and psychology from Washington University and the University of California (Berkeley).

— **Ronald M. Latanision,** on leave from the Max Planck Institute in West Germany, is Associate Professor of Materials Science and Engineering; he was formerly a member of the scientific staff of Martin Marietta Laboratories. Dr. Latanision's work is in the mechanical behavior of crystalline and vitreous solids and in metal cutting.

— **David K. Roylance,** formerly Visiting Lecturer in the Department of Civil Engineering, is Associate Professor of Materials Science and Engineering, where he will work on the mechanical properties of polymers and composites. He holds degrees from the University of Utah and since 1970 has been associated with the Army Materials and Mechanics Research Center, Watertown, Mass.

— **Raymond T. Schnadelbach,** a partner in the firm of Schnadelbach-Braun, Inc., in Philadelphia, is part-time Associate Professor of Urban Studies. A landscape architect as well as artist, Mr. Schnadelbach has had design work exhibited at the Museum of Modern Art and the Whitney Museum of American Art in New York and the Boston Museum of Fine Arts; his degrees are from Louisiana State University and Harvard.

— **Phillip A. Sharp,** formerly of the Cold Spring Harbor Laboratory, New York, is Associate Professor of Biology. He studied at Union College (Kentucky) and the University of Illinois, and his current research in the field of molecular biology is supported by the American Cancer Society.

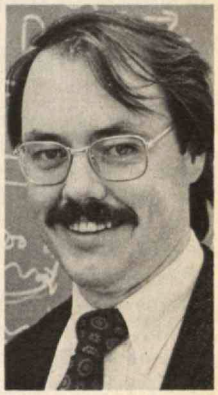
— **Robert M. Suskind,** who has been a member of the St. Louis University School of Medicine since 1970, is now Associate Professor of Medicine in the Department of Nutrition and Food Science; he is also Associate Program Director of the Clinical Research Center. He is a graduate of the University of Pennsylvania School of Medicine and holds a postdoctoral degree in tropical medicine from the University of Dakar, and he has worked as Field Director of the Anemia and Malnutrition Research Center in Chiang Mai, Thailand, and elsewhere in Asia and Africa in tropical medicine.

— **Lance J. Taylor,** formerly Assistant Professor of Economics and Research Fellow in the Center for International Affairs at Harvard, is Professor of Nutritional Economics; he'll work in the Department of Economics and with programs in international nutrition and food management which are centered in the Department of Nutrition and Food

S. C. Howell

D. K. Roylance

R. T. Schnadelbach



P. A. Sharp

R. M. Suskind

S. E. Widnall

Science. Dr. Taylor studied at California Institute of Technology, Harvard, and Lund University (Sweden) in the fields of econometrics, economic development, and mathematical economics.

— **Sheila E. Widnall,** '61, Associate Professor of Aeronautics and Astronautics who is on leave this year with the U.S. Department of Transportation in Washington, has been promoted to Professor. Her recent research has been on aircraft wake turbulence — an effect which currently limits runway capacity at a number of major U.S. airports. □

34 Visiting Faculty

Thirty-four specialists in engineering, science, architecture, management, and the social sciences are at M.I.T. for all or part of this year as visiting members of the faculty. They are:

— **Ilhan A. Birkan,** head of the Department of Mechanical Engineering at the Galatasaray School of Engineering, Istanbul, Turkey, Visiting Professor of Mechanical Engineering; Dr. Birkan is also a lecturer at the Technical University of the Black Sea, and he was formerly Dean of the School of Engineering at Besiktas, Istanbul.

— **Thomas H. Brylawski,** a member of the faculty at the University of North Carolina at Chapel Hill, Visiting Assistant Professor of Mathematics.

— **E. Eugene Carter,** Associate Professor at the Harvard Business School, Visiting Associate Professor in the Sloan School of Management.

— **Ming M. Chen,** Chairman of Aerospace and Mechanical Engineering at Boston University, Visiting Professor of Aeronautics and Astronautics. At Boston University since 1960 (when he graduated from the University of Illinois), Dr. Chen has worked on research with the Boeing Co., Argonne National Laboratory, and the Langley Research Center.

— **Stuart B. Crampton,** Assistant Professor of Physics at Williams College, Visiting Assistant Professor in the M.I.T. Physics Department.

— **Sheldon L. Glashow,** Professor of Physics at Harvard, Visiting Professor of Physics; he has been a consultant to Brookhaven National Laboratory and has worked at C.E.R.N. in Switzerland and the University of Aix-Marseilles in France.

— **Jeffrey Goldstone,** Lecturer in Applied Mathematics and Theoretical Physics at Cambridge University, England, Visiting Professor of Physics; he has taught at Cambridge, where he received both undergraduate and graduate degrees, since 1961, and he is also Director of Studies in Mathematics at Trinity College.

— **Goesta H. Granlund,** a member of the faculty at Chalmers University of Technology, Gothenburg, Sweden, Visiting Associate Professor of Electrical Engineering.

— **G. Robert Greenberg,** Professor of Biological Chemisty at the University of Michigan Medical School, Visiting Professor of Chemistry; Professor Greenberg studied at the University of Minnesota and was previously on the faculty at Western Reserve University.

— **Gabriel Y. Handler,** a member of the Technion, Haifa, Israel, Visiting Assistant Professor of Civil Engineering.

— **James D. Hedburg,** Manager of the International Division of Exxon Exploration, Inc., Crosby Visiting Professor in the Department of Earth and Planetary Sciences; Dr. Hedburg holds degrees in geology from Princeton and Stanford Universities.

— **Morgan Jones,** a member of the faculty in the Graduate School of Management at the University of California (Los Angeles), Visiting Associate Professor in the Sloan School.

— **Fritz S. Klein,** Head of the Department of Isotope Research at the Wiezmann Institute, Visiting Professor of Chemistry; he is a consultant to the Israel Atomic Energy Commission and has been a guest scientist at the Brookhaven National Laboratory, the National Bureau of Standards, the U.S. Department of Agriculture, and M.I.T. (in 1967).

— **Nancy J. Kopell,** a member of the Department of Mathematics at Northeastern University, Visiting Associate Professor of Applied Mathematics.

— **Kai Kroger,** Professor at the Technical University of Berlin, Visiting Professor in the Department of Metallurgy and Materials Science. A graduate of T.U.B., Professor Kroger's specialty is ferrous metallurgy.

— **Harold D. Lasswell,** Professor Emeritus of Law and Social Science at Yale who has recently been Visiting Research Scholar on Population Policy at the Harvard School of Public Health, Visiting Professor of Political Science. Dr. Lasswell, who is often referred to as "the father of modern political science," also holds for this year the Albert Schweitzer Distinguished Professorship in international affairs at Columbia University.

— **Shneior Lifson,** Professor in the Polymer Department of Weizmann Institute, Visiting Professor of Chemistry. He is a graduate of Hebrew University, and he held a similar post at M.I.T. in the fall term of 1968.

— **Dieter List,** a member of the Technical University of Berlin, Visiting Associate Professor of Nutrition and Food Science.

— **John P. Longwell,** Sc.D. '43, Senior Scientific Adviser in the Corporate Research Laboratories of Exxon Research and Engineering Co., Visiting Professor in the Department of Chemical Engineering; he will teach a graduate course on new energy technology in the second term, and he is working to define energy-related research activities in the M.I.T. Energy Laboratory.

— **John D. Malcolm,** a member of Memorial University of Newfoundland, Visiting Assistant Professor of Mechanical Engineering.

J. P. Longwell

— **James E. Mark,** Professor of Chemistry at the University of Michigan, Visiting Professor of Chemical Engineering for the fall term — through January, 1975. He has held similar posts at Stanford University and the University of Manchester, England.

— **David S. McClain,** Senior Economist for Data Resources, Inc., Lexington, Mass., Visiting Assistant Professor in the Sloan School.

— **David Moizer,** a registered member of the Royal Institute of Architects (England) who is Professor of Architecture at Carleton University, Ontario, Canada, Visiting Professor of Architecture.

— **Claudio Rebbi,** Research Associate at C.E.R.N., Visiting Associate Professor of Physics; he was formerly Professor of Physics at the University of Trieste.

— **Peter L. Rogers** of the University of New South Wales, Visiting Professor in the Department of Nutrition and Food Science.

— **Erik Sandewall,** who teaches at the University of Uppsala, Sweden, Visiting Associate Professor of Electrical Engineering.

— **Warren D. Seider,** a member of the Schools of Chemical Engineering and Electrical Engineering at the University of Pennsylvania, Visiting Associate Professor of Chemical Engineering.

— **William Simon,** Head of the Division of Biomathematics and Computer Science in the School of Medicine and Dentistry at the University of Rochester, Visiting Associate Professor of Electrical Engineering.

— **Abraham Szoke,** Associate Professor of Electrical Engineering at Tel Aviv University, Visiting Professor of Electrical Engineering; he was a member of the faculty in that Department from 1967 to 1970.

— **Valentine Telegdi,** Enrico Fermi Distinguished Service Professor of Physics at the University of Chicago, Visiting Professor of Physics; his doctorate is from the Swiss Federal Institute of Technology.

— **Previn Varaiya,** a member of the faculty at the University of California (Berkeley) since 1971, Visiting Professor of Electrical Engineering.

— **Herbert Weber,** who teaches at the Technical University of Berlin, Visiting Assistant Professor of Electrical Engineering.

— **Michael E. Werner,** also a member of the Technical University of Berlin, Visiting Assistant Professor in the Sloan School.

— **Koichi Yazaki,** Associate Professor of Physics at Rutgers University, Visiting Associate Professor of Physics. □

F. G. Worden

M. V. Edds, Jr.

New Leadership for Neurosciences at a "Turning Point"

Having reached the age of 70, Francis O. Schmitt, Institute Professor Emeritus at M.I.T., whose concept made possible the Neurosciences Research Program and whose leadership assured its success, has retired from his role as its Chairman and Chief Executive Officer.

He has been succeeded by a two-man team:

— Dr. **Frederic G. Worden,** Professor of Psychiatry at M.I.T. who has been N.R.P.'s Executive Director since 1970, is now chief executive with the title of Director.

— **Mac V. Edds, Jr.,** formerly Dean of the Faculty of Natural Sciences and Mathematics at the University of Massachusetts, Amherst, has been named Executive Director of N.R.P. Dr. Edds will also be Professor of Neurobiology in the Department of Nutrition and Food Science.

Dr. Schmitt himself, holding the new position of Foundation Scientist, will spend full time on research seeking to "bring together and codify new and powerful concepts in brain function which . . . are expected to bring about major advances in neurosciences during the next decade," according to the announcement.

Dr. Worden thinks N.R.P., an international center and clearing house for brain research operating under M.I.T.'s auspices, is at "a significant turning point." Brain science, he says, awaits "conceptual breakthroughs as powerful as those of chemical coding of genetic information"; these in turn will lead to a "substantive understanding of how the brain mediates the behavior and mind of man." Reaching for this goal, N.R.P. will emphasize a more flexible staff group so that leading neuroscientists and workers in related fields of chemistry, biochemistry, biology, neurology, and psychology — as well as mathematics and physics — can make short-term visits. They'll be formed into task forces to tackle specific research targets.

Dr. Worden has been at N.R.P. since 1969, and he has been Executive Director since 1970; trained as a psychiatrist, he was Professor of Psychiatry and a member of the Neuropsychiatric Institute at the University of California (Los Angeles) before coming to N.R.P. Dr. Edds has held teaching and research assignments in zoology, anatomy, and biology at Chicago, Pittsburgh, and Brown; his degrees are from Amherst and Yale (Ph.D. 1943). □

Weisskopf, Retiring in Physics, Turns to Music

It was billed as a gala evening — and it was all of that, as friends and admirers (including some distinguished former students) gathered at the Sala de Puerto Rico in the Student Center to pay tribute to Professor Victor F. Weisskopf late last fall.

This had been the first day of a two-day symposium *(see pp. 58-59)* honoring the physicist who retired from full-time teaching last June, and the evening program was a time for fun and relaxation — and especially for music, one of Dr. Weisskopf's loves . . . a night to "celebrate Viki in music," said Professor David H. Frisch, Ph.D. '47.

As master of ceremonies, Professor Frisch got off some good one-liners, including a few "in" jokes, to keep the merriment level high. Then the audience settled down for a chamber concert that featured Professor Weisskopf as pianist and conductor. As pianist, he joined with violinist Eric Rosenblith and cellist Jochen Heisenberg in Beethoven's "Trio in E-Flat Major." Their playing earned sustained applause and cries of "Bravo!," and Professor Weisskopf, who was in high spirits all evening, did a little skip of joy. Then he returned to the stage to conduct a chamber group, made up largely of Physics Department faculty, in a performance of Bach's "Brandenburg Concerto No. 3."

Professor Frisch was a member of the group ('cello), which he dubbed the "Union of Concerto Scientists," a takeoff on the Union of Concerned Scientists whose main concern is opposition to nuclear power plants. Another of the musicians was Professor Kerson Huang (violin), one of the organizers of the event; Professor Frisch called him the "Sol Hurok of theoretical physics." The other musicians were Martha Jaffe and Professor Hale Bradt, violins; Professors Alan Grodinsky, Bernard Burke and Louis Howard, violas; Professors Jochen Heisenberg, June Matthews and George Clark, 'cellos, and Professor Francis Low, cembalo. — *Charles H. Ball.* □

After finishing his assignment as Conductor of the "Union of Concerto Scientists" (above), Professor Victor F. Weisskopf responded to the audience enthusiasm with a deep bow; and then he moved with a spring in his step to greet colleagues and friends in the Sala de Puerto Rico this fall at a party in his honor upon retiring from full-time teaching. Professor Weisskopf, a member of the Department of Physics since 1945, was its Head from 1966 (when he also became Institute Professor) to 1973.

Gus Solomons Company dancers feel that each viewer should be free to interpret their contemporary dance as his own experience dictates. It is essential to them to have a mutual interplay between the participants and the onlookers; ideal performance spaces are large rooms — like the lobby of M.I.T.'s building 7 where they appeared for a week in 1972.

Liquid Architecture

"It started, I guess, in Sunday school . . . we were singing a hymn with a fantastic beat — and I found myself dancing out in the aisle." But only a scolding resulted at the time, Gustave Solomons Jr., '61, remembered with a wry smile.

"It was like leading two separate lives," he said, "as a student of dance in the evening at the Boston Conservatory; an architecture student during the day. I slept very little, had boundless energy, and enjoyed everything tremendously." But architecture was certainly not always of secondary interest to dance. "It wasn't until I was a sophomore at M.I.T. that I began modern dance lessons, with Jan Veen in Boston. First it was one evening a week, then two, then many. I had always been limber, and music study was a part of my background — eight years of piano lessons." Nor was the decision made during studies at M.I.T. to pursue a career in dance. "I was offered a job dancing as soon as I graduated — before I found one in architecture — and from then on that's what has engulfed my time and energies."

"Do you regret giving up architecture?" I asked. He immediately shook his head no. "To me, dance is a kind of liquid architecture. . . My dances are 'structured energy,' pure motion influenced by my architectural concept of design."

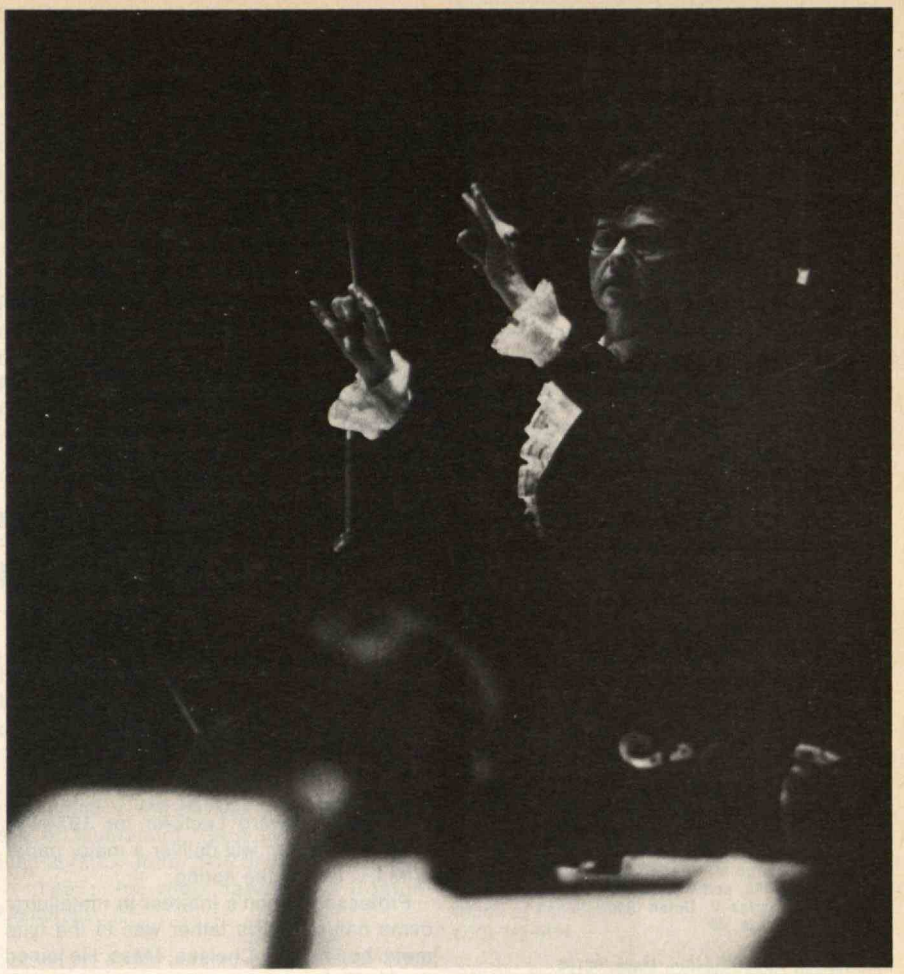
On his own, Mr. Solomons has choreographed and performed on the major TV networks; in 1968, for National Educational Television under a Rockefeller Grant, he performed an award-winning dual screen experimental dance piece. He has danced as a soloist in many companies, including Donald McKayle, Joyce Trisler, Pearl Lang, Martha Graham. But the primary influence in his evolution as a dancer-choreographer: "The association I value most, is that as a member of the famous avant-garde dance troupe of Merce Cunningham. I toured and performed throughout the U.S., Canada, and Europe with them from 1965 to 1968."

In 1971, the Solomons Company/Dance was formed in New York, with seven dancers. Mr. Solomons writes of the concept behind their performance: "We call our group — what we do — concert dance; I'm dealing with motion as a medium. There are no political or social overtones. My ideas don't originate specifically from my black background, although of course they are personal. Without literal meanings, our dance deals with kinesthetic and spacial relationships, organized during various kinds of chance and game rule procedures, many of which occur during the actual performance. The movement is shaped and shaded by the dancers' own personalities. The dance is more than abstract; abstraction is rooted in the concrete, whereas my dance is non-objective. There is no concrete influence; energy alone produces the result. The open structure and pure move-

ment of the dances make them adaptable to the widest variety of open spaces, theater stages, and non-theaters alike. Large open rooms, like gymnasiums, galleries, assembly rooms, plazas, malls, etc. are ideal for our presentations — spaces in which the spectators are not separated from the dancers and can relate visually and kinesthetically from all sides. Each different vantage point reveals relationships in space and motion which are unique to each individual viewer."

It is not easy to earn a living as a dancer. "I was lucky," Mr. Solomons told me, "I always earned money in related jobs [teaching in universities including Harvard, U.C.L.A., American University, N.Y.U., University of Rochester, Connecticut College]. Many dancers have to do something entirely unrelated to make a living."

What is a Solomons Company/Dance performance like? From Don McDonagh in *The New York Times*: "The dances of Gus Solomons Jr. usually titillate and, at the same time, they caress the eye with a flow of long-limbed and neatly phrased images. Solomons is a rigorously intelligent choreographer with passion as well as a marvelous flair for performing. With care he corrals his own passion but allows his audience to spread its feeling all over his precise dances. The result is a pleasing combination firmly supported by the sound structure of his pieces." — *M.L.* □



Our First Guest Conductor: It was a Love Affair

Dalia Atlas, Conductor of the Technion Symphony Orchestra, spent a month at M.I.T. early in the winter as the M.I.T. Symphony Orchestra's first Guest Conductor. A fine experience, she told Stephen H. Owades, '75, of The Tech; *she was "most impressed" with the M.I.T. Music Division. She found at the Institute the same "strong connection" between science and music that she knows at the Technion: "If you do science in a permanent way, and continue to do music as well, you can fulfill all of the desires, shall I say, of your soul," Ms. Atlas told Mr. Owades.*

"I really fell in love with this orchestra! . . . I have never felt so good with any orchestra . . . magnificent results."

Those are among the comments of Dalia Atlas, Conductor of the Technion Symphony Orchestra and the Israel Pro Musica Orchestra, while she was the first-in-history Guest Conductor of the M.I.T. Symphony Orchestra during the fall.

The occasion was the absence of the M.I.T. Symphony's regular Conductor, David M. Epstein, on a guest-conducting mission of his own. Ms. Atlas' visit was the first half of an exchange that will later take Professor Epstein to the Technion in return. She worked with the Orchestra to prepare a concert which included Beethoven's *Egmont Overture,* Zvi Avni's *Meditation on a Drama,* the Boccherini *B-flat Cello Concerto,* and Debussy's *La Mer.*

The Orchestra liked her. "The response of an orchestra to a guest conductor is a difficult test of its abilities and flexibility," thinks Stephen Owades, '75, who interviewed Ms. Atlas in her McCormick Hall living room for *The Tech* as her visit was ending. Mr. Owades says Ms. Atlas and the Symphony "worked well together," and he thinks the concert was "outstanding." His summary:

"The Beethoven had strength and solidity as well as excitement, the Avni work (an American premiere for this contemporary Israeli composition) elicited fine playing from a wide variety of solo instrumentalists, Boccherini's elegant concerto demanded and received a lightness and buoyancy remarkable in so large an orchestra, and *La Mer* was a marvel of coloristic subtlety and carefully shaped phrasing."

When she first met the Symphony "it felt like I was at home," Ms. Atlas told Mr. Owades. "Scientists making music have the ability to get over difficulties, even technical difficulties, by analyzing the problem, and they can often perform on a level no lower than that of professional musicians.

"You have the same material here; they are so fast, they respond so immediately to whatever you say to them, they have appreciation, imagination, everything!" □

Turning Metallurgy into Materials Science

Morris Cohen, '33, Ford Professor of Materials Science and Engineering, has for three decades been a key figure in the union of engineering and science which has turned metallurgy into a broadly based technology of natural and man-made materials. Now, as one of the world's leading metallurgical scientists, he has the additional distinction of an Institute Professorship at M.I.T.

The title is reserved for "scholars of special distinction," and it is given only on the basis of nominations by colleagues on the M.I.T. faculty. President Jerome B. Wiesner says that, "among metallurgists and materials scientists, Morris Cohen is known world wide for his penetrating understanding of the structure of matter and how materials of many kinds are processed to provide

M. Cohen

devices and aggregates of matter that are useful to man."

Professor Cohen has had a major role in almost every national study, workshop, conference, or commission concerned with materials, materials science, or materials engineering education convened in the last decade. He was Chairman of the distinguished National Academy of Sciences survey of materials science and engineering (COSMAT); he is a past President of the American Society for Metals and has twice won its Howe Medal; and he has been a major force in the revision of curricula at M.I.T. to provide students an interdisciplinary view of materials science and engineering.

As Killian Award Lecturer for 1974-75, Professor Cohen will deliver a major paper at M.I.T. during the spring.

Professor Cohen's interest in metallurgy came naturally: His father was in the type metal business in Chelsea, Mass. He joined the M.I.T. faculty upon receiving his doctorate in metallurgy (1936), and he became Ford Professor in 1962 when a series of interdisciplinary chairs in engineering was established with help from the Ford Foundation. □

Individuals Noteworthy

Kudos: Honors, Awards, and Citations

Four M.I.T. professors have received awards: To **Harry C. Gatos,** Ph.D. '50, of the Departments of Metallurgy and Materials Science and Electrical Engineering; and **August Witt,** of the Department of Metallurgy, the Exceptional Scientific Achievement Medal of N.A.S.A. for experiments growing crystals in space in the Skylab program . . . Professor Gatos was also the recipient of the Solid State Science and Technology Award of the Electrochemical Society . . . to **Morris Cohen,** '33, Professor of Materials Science and Engineering, the Killian Award Lecturer for the 1974-75 academic year . . . to **Malcolm L. Gefter,** Associate Professor of biochemistry, the 1975 Pfizer Award in Enzyme Chemistry "for his discovery, isolation, and study of enzymes catalyzing the biosynthesis of DNA in bacteria."

To **Niti Salloway,** Associate Producer in the Center for Advanced Engineering Studies at M.I.T., the 1974 Maya Deren Prize of Boston University for her film, *Clare* . . . to **William A. Baker,** '34, lecturer in the Department of Ocean Engineering, the Award of Merit of the American Association for State and Local History, "for research and writing contributing a greater understanding of the Kennebec River region and Maine maritime history" . . . to **Cecil H. Green,** '23, an Honorary Doctorate in Science from the University of Massachusetts in June 1974 . . . to **Robert M. White,** Sc.D. '50, the 1974 Rockefeller Public Service Award for the Development and Protection of Physical Resources.

Glen A. Brunk, '71, and **Robert P. Hooker,** '67, presently seniors at the Indiana University School of Medicine, were elected members of Alpha Omega Alpha, an honorary medical organization . . . **Thomas B. King,** former head of the Department of Metallurgy and Materials Science at M.I.T., to Fellow of the American Metallurgical Society . . . **Harold Chestnut,** '39, Fellow of the Instrument Society of America . . . **Norman L. Weiss,** '23, Honorary Member of the American Institute of Mining, Metallurgical and Petroleum Engineers . . . **Charles H. Norris,** Sc.D. '42, Honorary Member of American Society of Civil Engineers.

The American Public Health Association honored **Harriet Louise Hardy,** formerly Assistant Director of the M.I.T. Medical Department, with the 1974 Edward Browning Award for her contributions in the prevention of disease and occupational health hazards, and **Nevin S. Scrimshaw,** Head of the Department of Nutrition and Food Science, the International Award for Excellence in Promoting and Protecting the Health of the People, the Association's highest award. . . . **William B. Klee,** '33, and **Stanley M. Proctor,** '45, were presented medals from the Garfield Society, a society formed to recognize individuals whose careers and public lives have been outstanding.

To **Paul J. Flory,** Visiting Professor of Chemical Engineering at M.I.T., the 1974 Nobel Prize in Chemistry for his achieve-

The President of Hiram College, Elmer Jagow, presents medals from the Garfield Society to William Klee, '33 (center), and Stanley Proctor, '45 (right) in recognition of their outstanding careers and public lives.

ments in the study of the physical chemistry of macro-molecules, which include materials such as polymers . . . to **David L. MacAdam,** Ph.D. '36, the Ives Medal of the Optical Society of America . . . to **Paul A. Samuelson,** Institute Professor in the Department of Economics, the Distinguished Service Award in Investment Education from the National Association of Investment Clubs . . . to **Uncas A. Whitaker,** '23, the Distinguished Achievement Award of the Alumni Association of Carnegie-Mellon University . . . to **William H. Klein,** S.M. '44, the U.S. Commerce Department gold medal "for his leadership in improving techniques of weather forecasting and analysis" . . . to **David Bushnell,** '60, the 1974-75 Research Award in Structural Mechanics which is cosponsored by the Office of Naval Research and the American Institute of Aeronautics and Astronautics . . . to **Stephen A. Hill,** '69, the $100 Second Prize in the 1974 Nathan Burkan Memorial Competition of the American Society of Composers, Authors and Publishers for his essay, "State Protection of Intellectual Property: The New Limits and Their Effects."

Contributing New Ideas

M.I.T. mathematics professor, **James R. Munkres,** had a textbook, *Topology: A First Course,* published recently . . . **Olin Stephens,** '30, was the designer of another America's Cup winner, the *Courageous* . . . **Philip F. Palmedo,** Ph.D. '62; **David C. White,** Ford Professor of Engineering and Director of the Energy Laboratory of M.I.T.; **Karen R. Polenske,** Associate Professor of the Department of Urban Studies and Planning at M.I.T.; and **Michael S. Barum,** Associate Professor of the Department of Civil Engineering at M.I.T., were chosen as members of a panel of advisors by N.Y. State Senator Jay P. Rolinson, Jr., for a regional conference on the legislative response to the energy crisis.

Counselors: Officers, Directors, and Advisors

Arthur P. Stern, formerly Professor in the Department of Electrical Engineering at M.I.T., has been elected President of the I.E.E.E.; and **Joseph K. Dillard,** S.M. '50, formerly M.I.T. Professor of Electrical Engineering, to Executive Vice President of the I.E.E.E. . . . **Christian J. Matthew,** '43, President and Chief Executive Officer of Arthur D. Little, Inc. . . . **Gerald L. Murphy,** '57, to Director of Evanston Federal Savings and Loan Association . . . **Francis M. Staszesky,** '42, elected to the Atomic Industrial Forum . . . **Robert W. Lundgren,** '40, to Executive Vice President-Administration of Detroit Edison . . . **Jared J. Safirstein,** '57, President of Advertising Information Services, Inc. . . . **Diana C. Donald,** M.C.P. '58, to First Vice President of the American Institute of Planners.

Bernard P. Spring, M.A.R. '51, to New York State Board for Architecture by the regents of the University of the State of New York . . . **A. Donald Arsem,** '44, Chairman of the Board of the Wurlitzer Co . . . **Albert H. Teich,** '64, Research Director of the Institute for Public Policy Alternatives . . . **Edward E. David,** Sc.D. '50, and **Richard S. Morse,** '33, to the Aerospace Corporation Board of Trustees . . . **Edward C. Levy, Jr.,** '52, to the Board of Trustees of the Detroit Institute of Technology . . . **Kenneth L. Block,** '47, Chairman of the Board of A. T. Kearney, Inc. . . . **Steven I. Freedman,** '56, Assistant Director for Power and Combustion, Office of Coal Research, U.S. Department of Interior . . . **Arnold R. Weber,** Ph.D. '58, Board of Directors of the Aluminum Company of America . . . **Robert J. Davis,** '40, President of the International Trade Division, Champion International.

Herman Klugman, 1885-1974

Herman Klugman, Assistant Professor, Emeritus, in the Department of Foreign Literatures and Linguistics, died on December 9; he was 89.

Dr. Klugman, who held the Ph.D. in mathematics and physics from the University of Wuerzburg, Germany, taught German at M.I.T. from 1945 until his retirement in 1957; he also taught at Boston University. □

Clair E. Turner, 1890-1974

Clair E. Turner, D.P.H. '28, a pioneer educator in the field of public health who was Professor Emeritus of Biology and Public Health at M.I.T., died on November 26 at his home in Arlington. He was 84.

Dr. Turner first came to M.I.T. in 1914 as a research assistant in biology after completing his undergraduate work at Bates College. He became a member of the faculty in 1919 and Professor of Biology and Public Health in 1928, a position he held until 1944. During this period Dr. Turner established the first program in the U.S. leading to the M.P.H. degree with specialization in health education, and he taught the first course in health education ever offered in a school of public health.

He also taught for shorter periods at the medical and dental schools of Tufts College and the University of California (Berkeley), and he lectured at the Universities of Hawaii, Calcutta, Philippines, and Central China.

During World War II Dr. Turner was Chief of Health Education on the staff of Nelson Rockefeller, the Coordinator of Inter-American Affairs; later he was for 12 years Special Assistant to the President of the Na-

tional Foundation for Infantile Paralysis. Thereafter, until early in the 1970s, Dr. Turner worked extensively for the World Health Organization and UNESCO in Europe, Africa, and Latin America.

Dr. Turner was the first President, from 1951 to 1956, of the International Union for Health Education; and he continued as its Chief Adviser until 1968. Thereafter he was its Honorary President until his death. Dr. Turner studied for master's degrees in public health at Harvard and in education at Boston University; he held many professional and national honors and was the author of more than 100 professional articles and some 27 books. □

Deceased

Albert E. Greene, '07; July 22, 1973, P.O. Box 71, Medina, Wash.

Louis S. Gordon, '08; November 16, 1974, Apt. 1532, 910 West Ave., Miami Beach, Fla.

John W. Beal, '09; December 3, 1971, 178 Broadway, Hanover, Mass.

Leroy R. Block, '13; July 19, 1973, 501 South Ave., Pittsburgh, Penn.

John F. Foley, '13; November 17, 1974, 14 Stuyvesant Oval, New York, N.Y.

Alfred H. Parthum, '13; August 2, 1974, 7308 N. Manning Dr., Peoria, Ill.

Paul W. Brown, '14; June 2, 1974, 8515 Stenton Ave., Philadelphia, Penn.*

Estus H. Magoon, '14; November 9, 1974, 6040 South West 28th St., Miami, Fla.*

Arthur W. Mudge, '14; October 16, 1974, P.O. Box 1303, Clearwater, Fla.*

Leonard Stone, '16; October 10, 1974, 34-16 85th St., Jackson Heights, N.Y.

Walter F. Pond, '17; October 24, 1974, Box 291, Greybull, Wyo.*

Timothy H. Weston, '17; November 16, 1974, 180 Low St., Newburyport, Mass.*

Laurence A. Gillett, '19; September 13, 1974, Apt. A-3, 7520 Hampton Blvd., Norfolk, Va.*

Laurence Winant, '20; November 7, 1974, Box 413, Millbrook, N.Y.*

Armistead L. Wellford, '21; August 23, 1974, 2211 Orchard Way, Bluefield, W. Va.*

George W. Gibb, '23; July 11, 1973, 60 Granite Pl., Milton, Mass.

Francis J. Coughlin, '25; October 18, 1974, 10 Dorino Pl., Cincinnati, Ohio*

Francis E. Wilmot, '25; October 8, 1974, 205 Tyson Dr., Falls Church, Va.*

James E. Forbes, '27; November 18, 1974, 1434 Punahou St., Honolulu, Hawaii*

Harlan E. Glidden, '31; October 22, 1974, 21 Putnam St., Beverly, Mass.*

W. Jim Roberts, '31; September, 1974, P.O. Box 8003, Pompano Beach, Fla.*

Robert T. Shipp, '32; August 5, 1974, 105 Underhill Rd., Scarsdale, N.Y.

Roger J. Zampell, '32; October 21, 1974, Apt. 209-Bldg. 7, 4520 N.W. 36th St., Fort Lauderdale, Fla.*

Charles H. Mapes, '34; July, 1974, Norfolk Naval Shipyard, Portsmouth, Va.*

John E. Bone, '41; November 16, 1974, 85 N. Pleasant Ave., Ridgewood, N.J.*

Gordon F. Wadge, '43; September 11, 1974, 339 Aurora Ave., Metairie, La.

Roger Saint-Denis, '44; June 1974, College de Saint-Boniface, Saint-Boniface 6, Manitoba, Canada

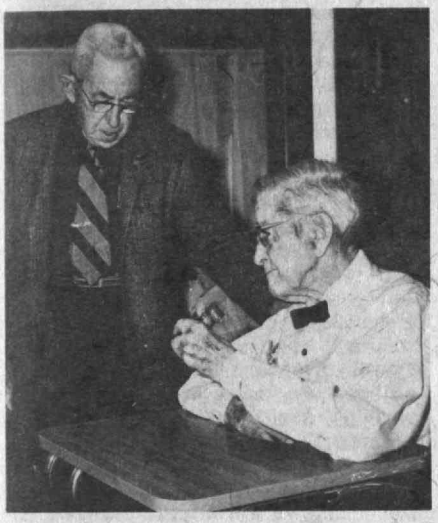
Clarence T. Ford, '46; March 15, 1974, 2425 Huntington Dr., Bridgeville, Penn.

George M. Robinson, '50; August 25, 1974, 514 Harriett Lane, Havertown, Penn.

John S. White, '60; October 5, 1974, 792 Avenue A, Bayonne, N.J.

* Further information in *Class Review*

Class Review



Oliver Hahn, Thomaston selectman, presents Richard O. Elliot with the Boston Post Golden Cane Award.

96

The tradition of presenting the oldest citizen of a New England town with a gold headed cane is still carried on in Thomaston, Maine. **Richard O. Elliot,** who celebrated his 102nd birthday on the sixth of this month, has qualified for this honor in his native town and was recently the recipient of this symbol of seniority. — **Clare Driscoll,** Acting Secretary, St. Joseph H.S., Frederiksted, St. Croix, U.S.V.I. 0082

99

A note has been received from **Carroll W. Brown**'s nurse, because Carroll lost his sight suddenly a few years ago, and here is a portion of the note: "His health is good and so are his spirits. He is alert and can still find things to fight about with me. I think he loves an argument." Carroll is living at his home in Rye Beach, New Hampshire. — **Norman E. Seavey,** Acting Secretary, Apt. 514, Lucerne Towers, Orlando, Fla.

04

I had a nice visit with Mrs. **Carle Hayward** last week. She is living at the Wellesley Manor Nursing Home and a friend volunteered to give her a ride over to Needham to call on me. She looks very well and is as keen as ever. We enjoyed talking about old times and old friends.

I received a notice recently of the death of **Edward W. Edes** — no details. I remember he took the Civil Engineering course at the time I did.

That is about all the class news for this issue. I guess '04 news reporters are like some others — on strike for more money or additional fringe benefits.—**Eugene H. Russell, Jr.,** 82 Stevens Rd., Needham, Mass

08

No news available.

We are sorry to report the deaths of two of our classmates: Gertrude Marvin (**(Mrs. John H. Williams)**, Philadelphia, Penn., died April 16, 1974 . . . **Louis S. Gordon,** Miami, Fla., died November 16, 1974 at age 90.

There are six other classmates that we are unable to locate. Any information of their whereabouts is welcome: **Thomas H. White,** Whitman, Mass.; **Edward Kloberg,** 48 Harding Pkwy, Mt. Vernon, N.Y.; **Max Rohde,** 2 Horatis St., New York, N.Y.; **Ludwig F. C. Haas,** Lancaster, Penn.; **Ygnacio S. Bonillas,** Mexico; **Harry Webb,** 1428 Monroe St., Memphis, Tenn. Letters to the above have been returned undelivered. — **Joseph W. Wattles,** Secretary, 26 Bullard Dr., Weston, Mass. 02193

12

I talked with **Jesse Hakes** and Mary by phone. They are both somewhat better, "as well as can be expected", and able to get about. Jesse is still maintaining the nursery which is still doing well. . . . **Mac McCormack,** our oldest classmate, wrote him recently and says he is fairly well, although his activities have become increasingly limited. . . . A brief note from **Paul Tyler,** Holmes Beach, Fla., indicates that both he and Katherine are reasonably well and able to keep busy. Like many of us, he is concerned about the present state of the stock market and is doubtfully hoping for an improving condition.

We regretfully report, belatedly, the death of **Theodore Hotard** on December 25, 1973, in New Orleans, La. He took a special course in architecture and spent much of his career with a New Orleans concern. He is survived by his widow but we have no other information.

This is the shortest news report I have prepared since I became your secretary in 1967. You all know the answer. Personally, except for arthritis with a daily headache and other pains, I am quite well and spent a happy Thanksgiving with five of my grandchildren. Please write me. — **Ray E. Wilson,** Secretary, 304 Park Ave., Swarthmore, Penn. 19081

13

When you read these notes, the holidays will be history. We hope you had a merry Christmas and we wish you a happy New Year. We thank all of our classmates (over 50 to date) who forwarded their yearly dues. Thirty stated that they hoped to attend the 65th Reunion; 15 replied that they would not attend the 65th, while the balance did not indicate their future plans.

We were pleased to receive a few comments or letters and we quote: **Henry Glidden:** "Hope your summer was a pleasant one. For the most part ours was quiet, because of weather not conducive to taking trips, but we did get to Chappaquiddick for a few days and I managed to paint a bit. Did a number of small watercolors and one larger oil. Have to get new things ready for the up-coming show season of the local art association. Our only long trip was to New Hampshire for the wedding of our granddaughter, Audrea Johnson, in North Conway. Visited other relatives in New Hampshire and then to Vermont to reminisce with a cousin, Wellesley, '16, and found she had a guest from California, also '16, so you can imagine the yak-yaking to catch up to date. The color in New Hampshire and Vermont was superb. Have never seen it better, very brilliant and heavy. It is beautiful even here in Abington." . . . **Arthur W. Carpenter:** "In regard to the 65th Reunion, Irma and I would like very much to come east for it but have no idea now whether this may be possible. We have not attended a class reunion since Swampscott in 1948. The Ray Dinsmores ('14) have mentioned seeing you several times at M.I.T. meetings in Boston. I greatly enjoy and look forward to your 1913 class notes in *Technology Review*. In the July/August issue you discuss some ideas on exhibits of work in the fine arts (particularly painting and sculpture.) It is indeed true that technically trained people seem to be turning to the arts more and more for hobbies and recreation. In our case it is music; 53 years ago the Akron 'Friends of

Music', of which I am a charter member, was founded by a group of music lovers who got together once a month to play string quartets and enjoy a social evening at various homes. The group now has 88 resident members and an average monthly meeting attendance of 60. Irma and I continue to enjoy the programs and will host the coming Christmas meeting in our home."

A note from **Gordon Howie:** "I remember many happy days in Maine at my Drake Island Home in Wells. While it was hot all summer here in Florida, I did not mind it too much, but I am happily looking forward to cooler weather in the approaching autumn and winter. I doubt that I can be present at the 65th Reunion." . . . A letter from **George W. Bakeman:** "I doubt greatly that we'll be able to get up to New England in the spring, though I'd dearly love to see the remainder of our gang. The world is treating me better than I deserve. Both Mollie and I are very well for our ages. My asthma keeps my outside work down to a minimum though I still keep the grass cut and have some nine gallons of my own grape wine fermenting in the cellar. There are always a million and one chores around the house and yard of course to keep me out of mischief. If it isn't a leaky toilet — it's a burned out fuse or the water pump needs attention. My M.I.T. training still serves me well. With affectionate greetings to all '12 and '13ers."

A note from **J. B. MacNeill,** "I see Mrs. **Roy Block** from time to time. She seems well but has given up golf." . . . From **Dave Stern:** "Enjoying being a volunteer SCORE (Service Corps of Retired Executives) counsellor for the Small Business Administration, trying to help small businessmen solve their problems. Also as a member of the Association of Management Consultants, I service private clients. Continuing as treasurer of the Jewish Memorial Hospital and the Boston Rotary Club." . . . From **Allen Brewer:** "We hope mightily to be with you in '78 at the 65th. Naturally four years from now is a long way off, but if we continue by the grace of the Lord to keep our good health, spirits, and the bureaucrats don't clamp down on our gas and other materials, we'll be with you folks once again.

"You know, speaking of materials, a while back I sent an announcement of my book to **George Wallace,** possibly for use in his company in Fitchburg. Well, 'blow me down' if I didn't get a nice phone call from him at his winter home here in Florida. We had a lengthy conversation during which he told me about his hobby of vintage car restoration. (An auction of his antique and classic cars was mentioned on page 120 of the December '74 *Review.)*

"Since our last letter I have proved that one can have a hernia operation by local anesthetic. It was interesting to lie on the operating table and hear all the chit chat of the surgeon and other personnel. I came through fine, only to return to normal chores." . . . A note from **Stanley Parker:** "Best regards to you and Ros and to all the other class of '13 members. Sorry, distance is too great for me." . . . From **J. W. Ladd:** "Aren't you planning our 65th reunion a little early? As I make it, our 65th comes in 1913 + 65 = 1978. Who knows where I will be by then." . . . From **Jack Horsch:** "Personal regards to you and your good wife, and thanks and appreciation for the excellent work you are doing for the 'best' class!" . . . From **Walter Muther:** "The garden was really prolific this year — filled the freezer plus with vegetables and ate off the land too. Now looking for a good wood stove for the winter, like the one in Beans Catalog, but hear that they are a year behind in deliveries. Have cords of wood waiting for it. Hope you all enjoy the winter." . . . From **Fred Lane:** "We have been well and have remained quietly at home in '74. Our main excitement has come from the building of an addition to our residence. The details of getting that done have kept us fairly busy of late. We have been amazed at the speed and methods of modern frame dwelling construction. Hope to attend the 65th."

There are several changes of address: **Halsey Elwell** has moved from Aiken, S.C. to RR#2, Bemidie, Minn.; **Allison Butts** is now at Lehigh Manor, Hanover Ave., Wahneta St., Allentown, Penn. 18103. One letter was returned "moved, no forwarding address": **Alonzo Mutersbaugh.** Can any of you, classmates, furnish the new address of Al Mutersbaugh? — **George Philip Capen,** Secretary and Treasurer; **Rozalind B. Capen,** Assistant Secretary, Granite Point Road, Biddeford, Maine 04005

14

Jim Reber has consented to accept appointment as our Class Estate Secretary. You'll be hearing from him in due course. . . . In a note written early last fall, **Walter Keith** mentioned that he's a life member of the Salvation Army in Akron and is in his third year as chairman of its Christmas Committee, which solicits 50,000 people to raise more than $100,000 for Christmas dinners and for new toys and dolls.

Paul W. Brown died on June 2, 1974. He was with us only in our second year, lived all his life in Philadelphia, and married the former Mary B. B. Daniel in 1917. The class records show that he was general manager of the Imperial Canning Co. in the '20's and went with the American Street Illuminating Co. in 1935. The 1967 Alumni Register lists Paul as director of the Richfield School.

Estus H. Magoon, 83, died at his home on November 9, 1974. He was born in Malone, N.Y. February 14, 1892, and was graduated from Purdue University in 1933. He received his M.I.T. master's degree in Course XI in 1914 and has been listed as a member of our class for much of the time since then. In 1917 he married the former Edna J. Meeker. Dr. Magoon came to Miami in 1947 when his office was moved from Havana. He had worked throughout Central and South America for the Rockefeller Foundation. He was a member of the First United Methodist Church of Coral Gables, the American Society of Civil Engineers and the Central American Society of Civil Engineers. Dr. Magoon is survived by his wife, two daughters, Mrs. Katherine Smith and Mrs. Dorothy Matejorosky; seven grandchildren and two great-grandchildren.

Arthur W. Mudge died in Clearwater, Fla. on October 16, 1974, at the age of 80. He graduated with us in Course V and made his career in chemistry. In 1919 he married the former Kathryn Wheting, who survives him. In the '30's he lived in Mamoroneck, N.Y. and later, for about 20 years, in Greenwich, Conn. He had had a home in Clearwater in recent years. — **Charles H. Chatfield,** Secretary, 177 Steele Rd., West Hartford, Conn. 06119

15

The many Christmas cards we received from widely scattered classmates and their families (especially from widows of our deceased) were warm reminders that the joy of Christmas is a good deal in living with the memories of fine old friendships. **Mary Plummer Rice, Joe Livermore, Sol Schneider** and **Vince Maconi,** wrote they are planning on our 60th here next June, we'll be glad to see them all. A pretty card signed by *Review* Editor John Mattill and his staff shows they really care. **Bert Adams** is enjoying the pretty Ohio Valley surroundings at Sewickley, Penn. . . . **Bill Brackett** is looking forward to another "ball and socket" operation in his right hip next Spring. What courage! A note of sadness runs through the messages in several of the cards. The complaints of illness are common at our age and unfortunate family upsets. Too bad! . . . **Bill Holway,** despite his age is still active in engineering practice. . . . **Jim Tobey** continues his serious professional writings and lecturing, but will be at Lake Worth, Fla. for the winter — ah, me! . . . **Ray Stringfield** has finally given up his professional career as a rubber consultant and has retired to the country-side.

Our sympathy goes to **Phil Alger,** whose wife Helen, died in Schnectady on November 30. A graduate of Vassar, with a Ph.D. later from Columbia, she had worked in the French hospitals in World War I. She had been very active in civic, church and community affairs in Schenectady.

James B. Carson died June 16 in Sonoma, Calif. **Ellis Ellicott** wrote from Baltimore that **Bill Spencer** died December 4 in Richmond, Va. Bill was an outstanding fellow in the class and had been Class Secretary in school days and later until he turned the job over to **Howard Thomas.**

Ellis wrote modestly, "I have been completely retired for about seven years now and I am glad to say that Ellicott Machine Corporation seems to get along quite well without me!" . . . From a long story in a recent New London, N.H. paper, we can see what an outstanding, generous and active citizen and fine, old classmate **Speed Swift** was: "The Tracy Memorial Library observed its 75th anniversary Thursday with the dedication of its New Hampshire Room and the unveiling of a portrait of the man to whom the room is dedicated, the late Herbert Dyer Swift. The recently renovated New Hampshire Room was furnished by New London resident Maude F. Swift in memory of her husband. Mr. Swift was one of New London's most prominent residents during his 38 years of residence in the town. During this time, he was New London's delegate to two state Constitutional Conventions, representative to the General Court for four years and a state senator. He also accumulated a long list of service accomplishments on many of New London's civic organizations. Within the sphere of local government. Mr. Swift was a leader in the effort to establish a Budget Board and to enact a zoning ordinance for New London. He was active in work for the New London Cemetery Commission and toward the institution of a town sewer system. "To the end of his days," said Dr. Squires in his address, "Herbert D. Swift devoted himself to his adopted town and to his state in a way and to a degree that made him one of New

London's outstanding citizens of the 20th century."

I was deeply touched by the many cards and messages received from the widows and families of some of our deceased classmates — a warm spirit of friendliness. — **Azel W. Mack,** Class Secretary, 100 Memorial Drive, Apt. 2-6A, Cambridge, Mass. 02142

16

Again, the mail bag is full. Our sincere thanks again to **Harold Dodge,** now on a brief leave of absence, and to **Len Stone,** who passed away last October, for the tremendous job they did for us as our Secretary and Assistant Secretary for so many years. . . . Let's start with this one from **Maury Holland.** "The excellent color picture of our Reunion keeps the memories of each fresh and close. The ranks may thin, but the bonds that tie us are classmates of more than a half a century when we and the U.S.A. were young, dreamers and drivers. Collectively, each to his own method, must now put that 'Horsepower' in the ballot box, not under the 'Hood' of gas and cash guzzling politicians whose only power is what we give them. Hot air propels 'Gas Bags' and 'Hell' is paved with promises. Let's make next year's Task Force Reports: what I did in my town to awaken 'The Spirit of 1916'. . . . **Herb Mendelson** recently wrote that he and Vi are well although they have been extremely busy and only now are "beginning to see a glimmer of light at the end of the tunnel". . . . Here's one from **Dina Coleman:** "I just returned from a trip to Evangeline County in Louisiana. We saw all of the historic places, and, of course, ate and drank entirely too much New Orleans liquor and food. We had **Vertrees Young** and Sylvia come down for lunch one day. He is in great form, and Sylvia has lost none of her spirit and enthusiasm. We had a delightful meal. "All of my 'Do-Good' enterprises are suffering for lack of money because, I presume, of the condition of the stock market. I do not understand my friends' state of mind about the stock market because as long as their stocks are paying dividends and they don't get panicky and sell, it really doesn't matter whether the stock goes up, down, or sideways. Personally, I am more concerned with the financial state of the Union. I don't know how much longer we can continue to borrow money to pay the interest on money already borrowed. Our Republic is in great danger of dissolution. Maybe it will not happen in our lifetime, but as sure as day follows night, the fiscal road we are following will destroy our present form of government. The puzzle to me is why our Congress does not see this. Hope to see you in June next."

Elsa Mueser brings us up to date with this one: "Almost too late. Back from Maine baby sitting for grandchildren, horses, donkey, ducks, chickens, cats, parakeet and wild life. Glad I could still run around in the dark with a flash light — glad I could can and freeze tomatoes, other vegetables, and cook too. Nice to hear from you and your pretty paper. I have four grandsons out of college, two grandsons in college — love them all. Last year travelled to Germany, Florida and Maine, always annoyed at waiting for planes, poor food, poor service but enjoy trips on arrival. Interested in politics now women are trying, but sad at so much apeing of men. Could do a better job on our own. Next thing we as women will try for facial hair and still larger feet." . . . **Kem Dean** commenting on the 58th Reunion photo wrote: "Most of those old boys look like they are in real good shape. Ada and I have very little to report this time. We went to two family weddings — in Casper, Wyoming on June 22, on May 25 in Shreveport, La. The only other event of importance was my 80th birthday on August 29 and I appreciated the card you sent me. I lived through that O.K. All of our grandchildren came to the dinner party for me at the home of my daughter who lives in Houston. One of my grandsons came from Washington & Lee where he is a senior, and the other grandsons came from Shreveport, La. and Baton Rouge, and then our oldest granddaughter came over from New Orleans where she lives. I was quite flattered to have all six grandchildren come to wish me many happy returns of the day."

A nice note from **Shatswell Ober:** "Just returned from memorial service for our classmate, Van Bush, praised by three former presidents of M.I.T., Harvard, Carnegie Institute, for his worth as a man, an educator, a scientist, a manager, an inventor and an author." . . . **Larry Knowlton** wrote: "My activities are not extensive nor worth reporting. Probably you and Theron are the only members of the class that would ever remember my name — so no news for your interesting column." . . . **Charlie Reed** continues on the move but found time to write: "My big news is that Mil and I have moved to a new apartment — The Promenade. It was a terrific job and we are still trying to fit in all our furniture and glassware — not to mention the canned food. The new apartment just won't hold it all. We spent an all too short two weeks on Anohoscoggin Lake in Wayne, Maine, in August, but had to come back to make this move. Thanks for sending the class photo of such a distinguished body of men and women."

We were glad to hear recently from **Henry Shepard** after several months of discomfort: "lately have begun to feel like myself again". . . . **Nat Warshaw** pleased us with this report: "Last weekend I spent with my younger son in Cromwell, Conn. I wanted particularly to see my youngest grandson born four months ago. I still take my daily three to five mile walk weather permitting. Once you get used to it, it is no chore. I wish everyone would do it." Nat also sent a newspaper picture and story relating to a celebration marking the 80th Anniversary of the building which in 1894 and for 30 years thereafter was Quincy High School and now is Central Junior High School. As a member of the class of 1910, Nat was one of the three from that class shown in the newspaper photo as being the oldest alumni to attend this function. He mentioned a sister who graduated from the same school before he did and who at 91 is now living in Oakland, Calif. . . . **Dick Berger** continues his public campaign for the preservation of good health with pamphlets on cancer and heart attacks. Remember when his was probably the earliest voice to be raised crying out the alarm about the danger of cigarette smoking. . . . We were happy to get a birthday card from the **Fairfields,** and John commented: "Can't help thinking of the scurry of events since we last met: Watergate, Ford, Kissinger, Rockefeller, inflation and the like. What a whirl of a world". . . . Also, we were pleased with early Holiday Greetings from Gladys and **Francis Stern,** Mertie and **Allen Giles,** Gypsy and **Cy Guething,** Sylvia and **Vert Young.** We'll close with this appropriate comment from Vert: "Keep breathing — that's a good slogan for the remnant of the Glorious Class of 1916 (Cy Guething has been saying this to us for years and it seems to be working.) — Keep your letters coming to me. — **Ralph A. Fletcher,** Secretary, West Chelmsford, Mass. 01863

17

Word of the death of **Dudley E. Bell** on November 26th permitted just a quick line in the January notes. The past few years were difficult ones for Dud with circulatory and respiratory problems. He was one of our most colorful and likable classmates starting right from the early days. He was a lifelong resident of Bristol, Penn. and lived in the house where he was born. He became well established as a manufacturers representative. His activities in the Society of Friends and in Masonry were extensive. Dud's interest in magic will recall to many his demonstrations, with his wife Helen, at several reunions. Our sympathy is extended to her.

Walter F. Pond died at Malvern, Ark. on October 25. After graduating from Amherst in 1907 where he was in private business before coming to M.I.T. where he received his masters in geology. His professional activities were extensive as State Geologist for Missouri, Mississippi and Tennessee. As chief geologist for the Magnet Cove Barium Corp. he traveled in the U.S., Greece, Brazil and Mexico. As a captain in World War I he received the Legion of Honor. His will provides for a bequest to M.I.T., the income to be credited to the 1917 Alumni Fund gift as long as a member of the class lives. After that the gift goes to the geology department.

Lew Sanborn feels his "news too bad to publish, seven operations in the last six years. Lost my wife one year ago this month." . . . **Ray Ramsey** and his wife were able to have "a six day cruise on the St. Lawrence River aboard the Russian steamer, 'Alexander Pushkin', the same ship that took us to Russia in '69." . . . **Dick Loengard** advises that the '16-'17 luncheons at the New York Chemists Club will meet on the Tuesday in the first full week of each month instead of Thursdays as before. At the December 3 meeting, Dick, **Enos Curtin, Will Neuberg, Clarence Seely** met with three 16ers. There is an open invitation to all who may be in town. Dick also reports that **Ed Aldrin** tried to attend the luncheon but could not. He was in town to meet son Buzz and asked Dick to join them which he was glad to do. Ed missed Northfield as he was just out from a hospital check-up. . . . Here are some more names of men whom it was good to hear from even though they could not take in our 57th Reunion: Collins, Fineman, Gager, Mathews, Westbrook, Ramsey, Payne, Stebbin, Chisholm, Bill Tuttle, Ames, Penn Brooks, Joslin, Dimlich, Gardner, Abels, Allen, Crane, Whitney, Plummer, Albert Chase, and Sewall. Thanks.

It is also with regret that the death of **Timothy H. Weston** on November 16 at Newburyport, Mass., is reported. —

Stanley C. Dunning, Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

Granny Smith, '18, and his wife, Dorothy.

18

News has been quite scarce from many of you for the past few months — therefore it takes a little ingenuity to fill these columns with Tech flavor. And so I have exposed myself to some of the things happening at M.I.T. — and here is my report. On December 5 Selma and I joined the undergraduates together with a few faculty and listened in room 10-250 (remember this lecture hall) to a seminar on The Justification for Inequality: The Contribution of Economic Theory by visiting Professor Kenneth E. Boulding. The audience was very attentive tho quite informal (blue jeans and hairdos!); the question and answer period showed real intellectual curiosity — all in the high tradition of quality that we expect of M.I.T.

Two nights later we were at Kresge Auditorium to hear the M.I.T. Symphony (all students plus a few faculty) under the baton of a guest conductor (Dalia Atlas from the Technion — The M.I.T. of Israel) in a concert comparable in quality to many professional organizations. The fact that the performance was sold out days in advance indicates a growth of student interest in aesthetics.

These two experiences bring to mind how M.I.T. has developed since our undergraduate days in its breadth of cultural activities. We can take pride in the response of todays students at the Cambridge campus to these values in the humanities.

Thanks to **Len Levine** we have the following news note from **Herbert J. Goldsmith:** "Answering your letter of Nov. 14th, '74 in reply to mine of three years ago, I manage to keep busy playing bridge, poker, gin rummy, golf and bowling and going to a show or the opera occasionally. I was glad to hear that you still have your marbles. As far as I know I still have mine. If you ever get to Tucson look me up and we'll get together in a game of marbles or at least a game of bridge."

I am happy that some replies are coming to me from my season greetings to you. The first of these from **Granny Smith** follows — others will appear shortly in succeeding issues.: "Again it is our pleasure to greet you at Christmas and to wish you health and happiness in the year to come; 1974 started off for us auspiciously enough with our usual activities, including the annual "Massing of the Colors" in February, sponsored by the Military Order of World Wars and supervised by Granville. A week later he had to go to the hospital to have an aneurism removed from his main aorta, and fortunately he survived with the aid of an accordion-pleated dacron replacement. His sister, Margaret, (also Dorothy's Vassar roommate) was not so lucky and died June 22nd in Springfield, Mo. after a long illness. We shall especially miss her at Christmastime, since she often visited us then.

"On the happier side, our two grandchildren, Allison and Stephen, flew down at Easter time for a week's stay, and in May younger son, Donald, and wife also spent a week with us. Older son, Roger, also came for a weekend visit. At the end of June we took the Auto-train north and spent a few days with friends in Washington and in New Jersey July 4-7 we attended the Disabled Officers convention in New York City, where we had a magnificent view of the city from the 23rd floor of the Waldorf Towers, made so enchanting at night by the lighted skyscrapers. The serious business of the meetings ended in a magnificent banquet, catered as the Waldorf can.

"Then we went on to visit the older son, Roger, and family in S. Windsor, Conn., and an old friend of D's in Sandwich, Cape Cod, before arriving at our usual haunt: Wayne, Me. Here we rented a lovely cottage on the shore of 5-mile long lake Androscoggin for two months, next door to some dear friends and not far from D's cousins. We had our own boat and dock and swam daily in the comfortably warm water. We had no TV to interfere with our reading, bridge and chess. We enjoyed riding through the beautiful and unspoiled countryside, once going as far as Southwest Harbor to see a friend. A short visit from two older grandchildren, Allison and Mark, made our summer complete. Farm-fresh vegetables obtainable nearby, as well as Maine lobster were an added joy.

"After Labor Day, we headed south to spend a week with the younger son, Don, and his wife in Gales Ferry, Conn., and a few days in New Jersey with a shipmate of last year's trip to Portugal. We took the Autotrain back to Florida after a party with D's former associates at the end of September and have been busy with civic and military affairs ever since. Our only granddaughter, Allison ("Randy"), age 18, again flew down from Hartford for a 10-day stay, and helped prepare the traditional turkey for Thanksgiving. We trust you also had a happy time then and will have everything you want in the New Year."

I report herewith the passing of **George Pierce** on February 2, 1973. . . . I also note similarly the death of **Raymond S. Smith.** Our sympathy is extended to both families.

— **Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine,** Assistant Secretary, 509 Washington St., Brookline, Mass. 02146

19

A note from **George Bond,** 127 Broad St., Paulsboro, N.J. 08066 states, "It was good to see so many of our classmates at the reunion on Cape Cod and most of them appeared to be in very good shape. My health has been excellent and I am busy every minute of the day. The days are just too short to let me do all I would wish. I hope everything is well with you." . . . Word from his daughter-in-law gives the arrival of **John Stevens** and wife to Boynton Beach, Fla. the second week of December for the winter.

The death of **Robert F. Lewis** in South Woodstock, Vermont on September 4, 1974 was announced by his wife.

Aubrey P. Ames says "Nothing eventful since last report except a trip last winter to the South Pacific, Australia and New Zealand, the last corner of the globe to be explored by my wife and myself." . . . A note came from **Ervin M. Kenison** saying he was in good health, and plays a lot of duplicate bridge and shuffleboard.

News reports that **Laurence A. Gillett** died on September 13, 1974 in Norfolk, Va. of coronary thrombosis. He is survived by his wife and his son Richard B. Gillett, M.S. '52, of Hudson, Ohio. — **E. R. Smoley,** Secretary, 50 East Rd. 11E, Delray Beach, Fla. 33444

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At this writing, a few days after our first reunion mailing, returns already indicate a highly successful gathering of the clan. More details on the 55th will soon be forthcoming. As we enter the bicentennial years, our class continues its lively and active doings. **Sam Schenberg** writes, "I had the foresight to marry Ruth two days after graduation which enables both of us to enjoy retirement in the warm climate of Miami Beach. I devote most of my time associating with new friends, playing golf and furthering the science education of interested youngsters." Doesn't sound at all like you were on the shelf, Sam. . . . **Dick Soderberg** writes that he is back again at 100 Memorial Drive and continues interesting and pleasant activities in industry. A genuine credit to our class, Dean Soderberg. . . . **Foster Doane** tells us he had an interesting trip sponsored by the M.I.T. 25 Year Club to Bucharest, Brasov, Romania and Kiev, the capital of the Ukraine. . . . **George Des Marais** writes that he has been "almost too busy" to get in visits to West Virginia, Maine, Vermont, Canada, Britain and France on the last crossing of the *S.S. France* of fond memory.

Scotty Wells spends summers in Kentucky and winters in Florida at Clearwater. He plays par three golf and disdains a power cart. He and his wife, Medora, go in for duplicate bridge. . . . **Skeetz Brown** holds forth at his winter residence, No. 68 Colonia Miramonte, Scottsdale, Ariz., where he says he entertained three of his classmates in December. He maintains open house for other visitors from the class. . . . A welcome note from **Roger McNear**

advises that he is still living on the desert in Tucson, Ariz., 6731 Andrews Drive. . . . **"Dolly" Gray** writes that he keeps at home in Sarasota on account of his wife's health. He wants to be remembered to all his old friends. . . . **Ed Burdell** continues super active as chairman of community relations and trustee of Winter Park Hospital. He gives lectures on how to maintain health and live with one's ailments, attracting an interested audience of up to 150 persons twice each month.

"Bat" Thresher is now living in Orlando, Fla., at 4868 Tangerine Ave. . . . Barbara and **Bill Dewey** write that they are wintering at their apartment, 220 126th Ave. E., Treasure Island, Fla. They now have eight grandchildren, one at the Air Force Academy and one a full colonel in the Air Force stationed at Izmir, Turkey. . . . **Jim Wolfson** celebrated his 50th wedding anniversary late last year in Florida with their three sons and families. Congratulations, Jim. . . . **Jim Scott** writes that he has two grandchildren in New England (Jim is in Richmond, Va.), one at Dartmouth, one at Putney, Vt. He also has one in Geneva, one in Philadelphia, one in Maryland, and seven in Virginia. A far-flung family. . . . Another who celebrated his 50th was Ella and **Al Wason.** They toured Britain, Scotland and Wales to mark the occasion. . . . Congratulations are also in order for Esther and **Frank Bradley** who achieved their 50th last June. Golden wedding anniversaries continue to mount. . . . Winnie and **Pev Warriner** had theirs in October on return from Hawaii, Scandinavia and England. The Warriners reside in Westfield, Mass. at 73 Llewellyn Drive.

Word has been received of the death of our well-known and beloved classmate, **Larry Winant,** of Millbrook, New York.

Harold Bennet of Denver died in November. A longtime resident of Denver, he was associated with private engineering firms there before joining the U.S. Bureau of Reclamation, where he served 41 years. He supervised the design of numerous power plants in the West, including Hungry Horse, Shasta, Glen Canyon and Grand Coulee. He was a life member of the Colorado Society of Engineers, a charter member of the Denver Chapter, Colorado Archaeological Society, a member of the Denver Museum of Natural History, the State Historical Society, the Denver Zoological and Botanical Gardens, a charter member of Historic Denver, Inc., a past member of the American Society of Civil Engineers, a member of the Middleborough Historical Association and a member of the Wyoming Archaeological Society. He is survived by his wife, Edith, a son and two grandchildren. An illustrious member of our class, he will be greatly mourned. — **Harold Bugbee,** 21 Everell Road, Winchester, Mass. 01890

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A nice long letter from Assistant Secretary **Josh Crosby** arrived in late November with bits of news about Florida 21ers. Josh and Claudia spent the summer at their cottage in Brooklin, Maine, and exchanged visits with Beth and **Whittier Spaulding** who were at Boothbay Harbor. The Crosbys took a trip around the harbor in the Spauldings' boat and enjoyed a picnic together on one of the islands. On his way home to Florida in September, Josh picked up a bad virus infection which his doctor couldn't identify and medicines didn't touch. However, after a long seige Josh says he's getting back to normal again. The M.I.T. Club of Southwest Florida had its first fall meeting on November 12, and attending were the **Herbert Kaufmanns,** the **Larcom Randalls,** the **James Parsons** and the **Crosbys.**

In the middle of October the Players of Sarasota presented "I Remember Mama" with Helga Lund Parsons, **Jim Parson**'s wife, in the title role. The reviews in both the *Sarasota Journal* and the *Sarasota Herald Tribune* were highly favorable: "The Players pulled out a winner and produced a new star, Sarasota newcomer Helga Lund. It was a natural casting choice since she grew up in a Norweigian family in Seattle and later spent five years with the Seattle Repertory Playhouse before going on to teach theater and write television serials. From accent to acting, she was Mama. . . . She is enchanting — with a Helen Hayes quality that immediately endears her to the audience, and she is in gentle but firm command all the way." Having heard Helga tell a couple of stories with a Norweigian accent last February at a mini-reunion at the Bardmoor Country Club, your Secretary can only wish he had been in Sarasota in October to see "Mama." A note from Helga said, "It was great being back on stage and I loved every minute of it." The Parsons were planning a two week Caribbean cruise in January on the Vistfjord.

Edward W. (Scripps) Booth wrote from Boca Raton, Fla. that he hoped a 1921 mini-reunion would be held this winter in the center or east coast of Florida. Your scribe hopes so, too, and would like to join them. Scripp's letter was sent on to **Al Lloyd,** interim reunion chairman, in Westerly, R.I. Scripps is busy as a tax accountant during income tax season but could probably take a day or two off to join other M.I.T. '21 men and their wives.

As of this date, Christmas cards are beginning to come in and your Secretary is particularly grateful to those who write a little news. Anne and **George Schnitzler** report they have bought a condominium in a town west of Fort Lauderdale and have moved from Miami. Their new address is 8544 N.W. 12th St., Plantation, Fla. 33322. . . . A card from Madeline and **Rufe Shaw** from Sanibel, Fla. states: "We are well and happy. Although I am old enough to retire, I am still in the saddle. Business is too much fun. As I told you, my partner had to retire and my daughter has taken his position as Vice President and General Manager (Pedrick Tool and Machine Co.). We have an immense backlog of orders and good relations with the trade." The Shaws as usual did quite a bit of travelling in 1974 and Rufe says he still has enough to pay the grocery bill.

My good West Coast correspondent has come through with another interesting letter. **Grant Miner** of Los Altos, Calif. writes that his wife Marianne's sister from Connecticut came out to visit recently and took home two plant clippings' "Creeping Charley" and "Falling Stars." Such names! Somebody suggested these should be the title of a song or short story, so after some head-scratching Grant wrote a short story for his grandson, a neighbor wrote lyrics and Marianne wrote the music. Is it copyrighted? How about a copy? Grant went on to tell of a new consulting job he has taken on with the Zenstaka Corp., a Japanese construction company incorporated in California, now entering the construction field in the U.S.

The **Irving Jakobsons** and the **Dayton Browns** had Thanksgiving dinner together at the Manhasset Bay Yacht Club. Jake writes that he and his summer shipmates, the McDowells, have chartered a sail boat for a two week February cruise in the Virgin Islands. Ruth Jakobson who can't take too much sun, is taking a week's cruise on a cruise ship and then will join the others for a week on St. Croix. . . . **Dugald Jackson** of Havre de Grace, Md. wrote to inquire the address of **Whittier Spaulding** in Sarasota. The Jacksons were spending Christmas with their son's family in Roanoke and then driving south if "the gods of weather and storms" were benign, to reach Mt. Dora, Fla., their winter habitat, just before New Years. Their daughter and family live in Mt. Dora. . . . **Alan Stewart Osbourne** of Cabin John, Md. who got an S.B. degree in Course XIII in 1921, keeps busy in retirement with rifle practice, canoeing, gardening, reading and church work. Tell us more.

It is our sad duty to record the death on August 23, 1974 of **Armistead L. Wellford** of Bluefield, W. Va. Wellford got an S.B. degree in Course VI and was Division Engineer for Appalachian Electric Power Co. The sympathy of the class is extended to his family.

My wife asks me to thank our '21 friends for the kind concern they expressed on hearing of her bout with surgery in November. — **Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby,** Assistant Secretary for Florida, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden,** Assistant Secretary for California, Lunden and Johnson, 452 South Spring St., Los Angeles, Calif. 90013

22

Our Hero of the Month is **Abbott L. Johnson,** Muncie, Ind. We don't get two letters in a month from many classmates. Ab reminds us Venice is in Florida and not in California. Although everyone knows it is really in Italy. He also insists he has not had a change of address from 80 Worwick Road, Muncie, Ind. 47302. We really only put that in to remind us that he is still a popular member of our class. In the winter, Ab's Phoenix address is Phoenix Towers, Apt 11C, 2201 North Central Avenue 85004, which has the welcome mat out to all classmates including privileges at the Phoenix Country Club. Ab also asks for publication of more complete addresses which we have been asked to shorten because of *Review* space. We will try including more detail and current addresses will also be published in the Alumni Register soon. Your Secretary is still only trying to do his best and boasts that any mistakes are strictly his own. Ab and Dottie were in Boston in September for the Alumni Officers Conference on the way to Venice, Italy; Dubrovnik and the Dalmatian Coast. They spent several days in Florence, Monte Carlo and Nice ending up with a week in Madrid. During November they travelled to Boston to attend Herrick Tappan's, '23, 75th birthday party and saw **Warren Ferguson**

and Ruth and **Yard Chittick.** They put frosting on the cake by attending three operas at the Metropolitan as they returned by way of New York City. Please remember to call or write the Johnsons this winter in Phoenix.

Don Carpenter has forwarded some notes on **H. Clifford Gayley** compiled for their Fraternity News. Clif had been in New York for many years having lived in Pine Orchard, Washington, D.C. and Buck Hill Falls. Clif was with Chrome Steel Company, then Schenley Industries and Lumber Fabricators in Alabama before returning to New York with I.B.M. He was later treasurer of Saint Bernard's School until passing away on the golf course at Buck Hill Falls in October. . . . Katherine and **Dale Spoor** have again had a year of travel as reported with their Christmas edition of peregrinations. Their complete survey of South America was exceptionally thorough and strenuous during March, but their tour of Great Britain last summer was more leisurely with an educational aspect. They do not consider their frequent M.I.T. visits any more than commuting jaunts. . . . **Wilfred M. Thomson,** 241 Evening Canyon Road, Corona del Mar, Calif. 92625, hopes to return to Phoenix for a visit with Ab Johnson and Dorothy this winter. He is hoping that Dale Spoor will again call on them when visiting relatives at Newport Beach. . . . **Lawrence Washington** is still enjoying full-time work as an aerospace engineer with N.A.S.A. at Ames Research Center. He hopes to continue this activity as it keeps him "feeling younger every day". . . . **Dwight F. Johns** of Piedmont, Calif. is enjoying retirement. He is planning on visiting his great granddaughter this winter in Arizona. . . . **Ray C. Ellis** of Dark Harbor, Maine reports again on his many trips to the Soviet Union studying Soviet trade unions and their functions. Ray has been in the U.S.S.R. 11 times. . . . **G. Dewey Godard** of Marblehead has been retired from General Electric since 1959 after 37 years of service. He is visiting his nieces and nephews for entertainment. . . . We were happy to hear from **Warren T. Ferguson,** 462 Mount Auburn Street, Watertown, Mass. 02172. He is preparing for a restful winter in and around Boston.

Clippings were enclosed telling of the funeral mass in November for **Frank H. Wing** of Chatham and Fort Lauderdale who has represented the Chrysler Corporation for 50 years. Frank was retired President of the Boston Automotive Parts Co. Our sympathy goes to his wife Reva and two sisters, Mrs. Ruth Bowen of Dennis and Mrs. Ester Bowling of Atlanta, Ga. . . . And now to plan for a visit with classmates in Florida, your Secretary will spend some weeks in Pompano Beach, Florida for golf and sunshine. Remember, "He who laughs — lasts". It's good for you. — **Whitworth Ferguson,** Secretary, 333 Ellicott St, Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

23

As **Tommy Rounds,** our class secretary and treasurer is making a prolonged visit to California and will then take an extended tour in the South Pacific area, our class notes will be handled by our assistant secretary, **Pete Pennypacker,** for a few issues. Any class information may be sent to him directly if addressed to Long Hill Road, Essex, Conn. 06426.

I received a phone call from **Dave Davenport,** who is keeping very busy as Resident Engineer for the Virginia Port Authority. He has no idea of retiring and works long days, — leaving the house at six A.M. and returning at six P.M. It may be that my experience with the Great History of our Class, which Dave and his wife Phyllis master-minded for us, is similar to that of a number of classmates. I keep referring to it and uncovering gems of information unnoticed in previous readings. The amount of information in this volume is really astonishing, and it is well seasoned with humor and interest. When people call on Doris and me and desire to know whether I know particular classmates whom they have met, it is easy to turn to the book and look up the records. The book is always considered to be outstanding, and the class is indeed indebted to Dave and Phyllis for the splendid job they have done in our behalf.

When I read in our "Great History" of the far-reaching accomplishments of some of our classmates as shown by the records of our illustrious president of M.I.T., — **Jay Stratton, Ping Yuan Tang, Cecil Green, John W. Beretta, Bill Lyman Stewart, Bob Hershey, Al Perlman, Toby Pearson,** and a long list of others, I feel inspired and uplifted to have known men of such outstanding potential, — and I wonder how they ever ordered their lives to accomplish such a variety of achievements. To all top leaders in our Great Class, I hereby express deep gratitude.

It is with deep sorrow and regret that I report the death of **David W. Skinner.** Through the years, Dave has been a leader in class activities. His classmates who knew his character well responded to his qualities of cheerfulness, dedication to his class, dependability, modesty, and his desire ever to be helpful and constructive. In spite of two strokes, — one in 1970 and the other in October, 1974, he fought bravely to carry on. He died in the Newton Wellesley Hospital on Saturday, November 16, 1974.

Dave Skinner was a former President of the class, Class Agent and Chairman of the 50th Reunion Gift Committee. In this capacity it was an honor for him to report on Alumni Day that the 50th Reunion Gift to M.I.T. from the Class of 1923 was $8,098,300; and, that in addition, 34 members of the class had already made plans for future gifts to benefit M.I.T. estimated to have a current value of approximtely $9,563,000. This all-time record reflected in large measure the efforts and dedicated service of Dave through a period of years. He was born in Chicago in 1902, joined Polaroid 27 years ago, and was retired in 1972. At the Polaroid Corporation, Dave became vice-president for manufacturing, vice-president and general manager, director and vice-chairman of the board and board member of subsidiaries of Polaroid. He was married to Isabelle Burbank of Pittsfield, Massachusetts. For years they have made their home in Waban, Mass. At the request of President Johnson of M.I.T., Dave served on the board of directors to establish the Charles Stark Draper Laboratory as an independent division of the Institute. He was a member, Board of Trustees, Brae Burn Country Club, Newton; Conservation Committee, Board of Directors, Newton Y.M.C.A.; United Fund of Boston; President Waban Improvement Society; Chairman Board of Trustees Andover Newton Theological School; Vice-president Opera Company of Boston; Charter Member of the Association for the Performing Arts, Boston. In World War II he served with the Massachusetts National Guard. He was Deacon, Moderator and Trustee of the Union Church of Waban.

A Memorial Service was held in the Union Church, Waban, for Dave on Tuesday, November 19. In his memory a Class gift was made to the Memorial Fund of this church. In a lovely letter from Isabelle Skinner she said, "I do want to thank the Great Class of 1923 for their Memorial Gift in Dave's name." She also informed me that on December 11, she will fly to their apartment in Sarasota and will return the latter part of April. She would be pleased to have any of our classmates who happen to be in the vicinity of Sarasota, Florida stop in and see her. I think she has attended all of our class reunions since our 25th.

Herb Hayden continues to improve from the serious set-back he suffered prior to our 50th. His wife, Katie, reports that he is gaining strength in his fingers, and that late last summer he was on the tennis courts again hitting the balls over the net, — but, of course, not running around the court or entering into strenuous exercise. Herb and **Neil Macneil,** (wearer of the H.T.T. and 1923 Numerals, Hockey) chum together to watch the Bruins play in the Wallace Rink at Pittsburg. Their interest in athletics is still as strong as ever. . . . As Helen and **Lem Tremaine** and Tommy and Marjorie Rounds have retired into the Heritage Village, Southbury, Connecticut, Doris and I were invited to join them at a lovely supper party late last Fall. . . . Roland Black, '24, also attended. He and I had roomed together sophomore year with **Samuel Williams** of Enfield, N.H. Naturally, we used this occasion to talk with Sam over the phone, — who was very surprised to find himself the "star" of our telephone reunion. Sam has retired from Westinghouse Airbrake Company with whom he became General Manager and President for a short time. It is still his theory that inflation can be met by careful investments in stocks. He also advocates that insurance benefits should be geared to cost of living indexes.

An early Christmas letter from **Forrey Lange** states that he is Chairman of the History and Heritage Committee, Region I, (New England States), A.S.M.E. Last May he was elected Vice-president of the New Hampshire Sons of the American Revolution. On October 12, he attended the Fort William and Mary Celebration, — and on November 23, he gave a Bicentennial paper to the S.A.R. in New London, N.H., on the subject "Fort William and Mary 1774, Prelude to American Independence and the Naval Defense Thereof." . . . **Cecil H. Green** received an Honorary Doctorate in Science from the University of Massachusetts in June of 1974. . . . **Normal L. Weiss** was elected an Honorary Member of the American Institute of Mining, Metallurgical and Petroleum Engineers on October 30, 1974 with the following citation: "In recognition of his distinguished contribution to the art of ore processing through a half a century of process development, mill administration and operation, and achievements in plant design; his service to the Institute and the Society of Mining Engineers in a number of

capacities including editorial responsibilities in connection with the Mining Engineering Handbook and the Mineral Processing Handbook; and, finally for his interest in the education and professional development of the younger engineers." . . . **Richard H. Frazier** is a co-author of a book "Magnetic and Electric Suspensions" which played a major role in the development of suspension devices at the M.I.T. Charles Stark Draper Laboratory.

I am happy and relieved to report that all boxes of records of the Class of 1923 have been turned over to the Director of Historical Collections at M.I.T., Mr. Warren Seamans, Chairman; and much of this information will be retained in their Archives. This move was made possible by the publication of "The Great History of a Great Class", — a copy of which is also on file with the Committee on Historical Collections of M.I.T. — **James A. Pennypacker,** Assistant Secretary, Long Hill Road, Essex, Conn. 06426

24

If our classmates detect a lack of the usual sage and delightful flavor in these notes, it is because they were prepared by Co-Secretary Steward instead of Secretary Ambach who was helping Ethel's convalescence at home after a brief hospitalization with a pneumonia attack in late November. I am sure I can speak for the class in all wishing Ethel well.

Favorable comments continue to come in various communications about our very successful 50th. For example, **Marshall Waterman** included in a letter to Russ: "That was a good report of our happy 50th in the October/November *Review*. The Watermans enjoyed it all very much and are grateful to you and the others who put it together." . . . **Ted Taylor,** in sending to Russ some reunion photos he took at the 50th, said: "Am looking forward to joining the group again on our 55th!" . . . From a member of the Class of 1919, included in a letter to Frank Shaw for acquiring one of Frank's stock of unmarked lucite picture cubes, came this congratulatory statement, (and interesting reference to **Luis Ferre**): "I have read with much interest the interesting and complete report of your M.I.T. '24 Class 50th Reunion. It seems I must admit, to be considerably more glamorous and innovative than my own 50th Reunion of the Class of '19 at Catham Bars Inn five years ago. I am referring to the *Technology Review*, October/November 1974 issue, which I have been reading today.

"However, I remember that I wore a Master of Science cap and gown for a couple of hours at the Commencement, and that your own classmate, Luis Ferre was an honored guest there, and made an interesting speech on that occasion. He was then governor of Puerto Rico. I was in San Juan as a tourist two years later, and visited the Governor's Mansion on a sight-seeing trip, but didn't have the nerve to call on him. I read in your class notes that he gave a fine buffet luncheon. Well, let me say again you all apparently had a wonderful time at your reunion, and you had very good attendance too."

At the request of **A. C. Read Jr.**'s family, Marshall Waterman wrote Russ as follows: "It occurs to me that you may not have received the word about Bert Read's death (of cancer on August 28). This is all I know except that as of last spring his wife was living, but an invalid. I am sure that you remember Bert from days on track. He was a close friend of mine. I believe he was in the real estate business and, so far as I know, spent his whole life in Little Rock." The Class' sympathy goes to Bert's surviving family. Marshall's letter went on to say that he expected to make contact with classmate **Bill McHenry** on a short trip to Washington in December (1974).

A note from **Chris Conway** accompanying Chris's Alumni Fund contribution says: "Am doing some consulting work for my former employer, A.T. and T. Co., having signed a seven month contract to work two weeks each month on a project at the Western Electric plant in Columbus, Ohio. All is well with us down here in Louisiana." We don't believe the anti-trust suit against A.T. & T. will imperil Chris's contract. . . . Edith and **George Knight**'s Christmas card to Russ indicates they are spending the winter again in England, Edith's homeland. Anybody desiring to contact them would find them at 117 Spring Lane, Bishops Stoke, East Leigh, Hauts S056AZ, England. . . . Hearty congratulations are due **Frank Reeves** for having received the Society of Manufacturing Engineers' 1974 "Inter-professional Achievement Award for outstanding contributions to both the professional and academic society as well as the community at large by extensive educational and civic activities which enhance the growth and prestige of the entire community" for an area comprising eleven western states. . . . *The New York Times* for December 7 carried the following item about **Dave Meeker:** "David B. Meeker, President of Hobart Manufacturing Corp. of Troy, Ohio, and newly elected chairman of the National Association of Manufacturers has said in a press conference a consensus of the Association members was that the economic situation would begin to rebound late in 1975. He also said he was hopeful that the economy would not sink much deeper than its current level, but was fearful that unemployment might worsen."

The publicity is now out on **Nish Cornish**'s 27th M.I.T. Fiesta in Mexico, March 13 to 15. Our Luis Ferre will be the guest of honor as President of the M.I.T. Alumni Association. Many events and trips are planned, including the delightful "Noche Mexicana" at the "Nishe's" residence. Complete information is obtainable by writing Mrs. Alma Gasio, at M.I.T. Club of Mexico City, Apartado Postal 31, Fracc. La Florida, Edo. De Mexico, Mexico.

"Adios" till next time! — **Russell W. Ambach,** Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart,** Co-Secretary, 8 Pilgrim Rd., Waban, Mass. 02168

25

Just to show you the difference between my time and your time, I am writing this early in December and by the time you read these notes a great deal of water will have gone over the dam. The notice for the deadline for these notes was illustrated with a picture of a snowman. I hope this is not an omen of things to come, but I am prepared. I removed my wife's snow shovel from the attic to the cellar. Harvard, a neighbor of mine, calls it "The Game" and I think we may call this "The Year." When you receive this it will be the second month with a few more to go before the Reunion. Jumping back to football I wonder what would happen if M.I.T. played. Would we computerize and have signals called depending on some theory of probabilities? . . . **Cliff Abrahamson** says that in addition to enjoying the '25 notes he also likes those of '26 as he and Warren Smith, who writes them, grew up together in Waltham. . . . **Don Taber** took an American Express tour in June which included Switzerland, Northern Italy and Austria, ending with a three days sail down the Rhine. . . . **Milt Salzman** is enjoying retirement. In the early summer he traveled to Great Britain with 100 members of a barber shop quartet group. They gave seven shows and two T.V. broadcasts to promote barber shop harmony. They were hosted by members of the British Harmony Clubs. I wonder if Milt could organize a group, class members of course, to furnish entertainment for the Reunion. . . . I shall try not to straighten out an error on my part. If you will refer to the July-August notes in which I mentioned a sin of commission by **Sam Spiker.** This was to call attention to the fact that I had earlier referred to the passing of **Fred Cunningham.** Somehow wires became crossed. Fred is very much alive and his death has been very much exaggerated.

I am sorry to have to report the passing of **Cecil C. Marble** of Quincy, Mass., on Dec. 21, 1973; of **Francis E. Wilmot** of Falls Church, Va. on Oct. 8, 1974; and of **Francis J. Coughlin** of Cincinatti, Ohio, on Oct. 18, 1974 — **E. Willard Gardiner,** Secretary, 53 Foster Street, Cambridge, Mass. 02138

26

An overcast morning in December with a northeast storm threatening is not the base for writing a bouncy issue of class notes — especially with the knowledge that I must drive to M.I.T. (45 miles) and return before the storm closes in. And that is where you come in. That space on the back of the Alumni Fund Envelopes is given to you for writing to your class secretary and I've been saving my envelopes for just such a day as today. Some are current — some not so current; but anything we hear from a classmate we haven't seen for up to 44 years is news. I find that when all of these cards are assembled they make interesting reading and I hope you will be encouraged to send yours along. Since the Postal Service stopped putting towns on their cancellations you may not know where the classmate is located but I'll ad lib where the comments do not give you a lead. Here we go.

We will start with one from **Allan Cobb:** "Still active as a consultant — still on New York State Building Code Council, many activities at Rochester Chamber of Commerce, National Safety Council and National Fire Protection Assoc. It's not a dull life." . . . From **Arthur J. Brockelman:** "Elected on March 5, 1973, at the Lunenburg, Mass. Town Election, to the Lunenburg Housing Authority." . . . From **William W. Farr:** "Retired from Rohm & Haas Co., Philadelphia, Penn., five years ago. Met and married Virginia Wolcott (widow), November, 1968 (I was a widower.) Moved to North Carolina and am enjoying golf, gar-

den and cruising once a year." . . . From **Joseph B. Merrick,** Rhode Island: "I retired recently as hydraulic engineer at the Reservoir Control Center of the U.S. Army Engineers at Waltham, Mass. after 37 years of service with the Corps of Engineers."

From **William M. Davidson:** "Since my retirement in 1969 we have been spending our winters at Sarasota, Fla. and our summers at our home in Gladroyne, Penn. Have been fairly active in consulting work — the most interesting being a four month stay in Taiwan consulting on their telephone system for the Chinese Nationalist Government." . . . From **C. Marvin Pickett Jr.,** Needham, Mass.: "On June 17, 1973 I received the degree of Master of Science in Civil Engineering (Sanitary Engineering option) from Northeastern University. I have now been with Camp Dresser and McKee Inc. for ten years, the same firm for whom I spent two years in Bangladesh." . . . From **Argo E. Landau,** St. Louis: "I have had a quiet year. Had a pleasant lunch with Chancellor Gray some time ago and dinner with Arnold Singal of the Development Department. Nice to hear first hand about M.I.T. Edna just returned from a month in Iceland and Greenland. All set for 14th trip to Hawaii. This time three weeks on Maui and five weeks in Honolulu, then home. Hope all goes well with you." . . . From **Bill Millar**'s 1973 card from Patagonia, Ariz.: "After 47 years of look-see in the mineral field, I'm still at it. Now researching a special project for Mt. States Mineral Enterprises — started in 1969 by Ed Frohling, an M.I.T. metallurgist, and a very swell guy! Pinning my hopes on catching the extra fine gold left in ancient and famous Arizona dry placers. New hydrometallurgy should turn the trick. Wish the old-timers had left more nuggets, though, for one or two!" Bill's 1974 card: "Anyone enjoying class notes should write one occasionally! I'm busier than usual as a shallow gold placer consultant specializing on accurate preliminary sampling. Not an easy problem, either! Know any '26er with a gold placer awaiting hot-shot elucidation?" (That last question mark was actually made out of mini gold nuggets glued on to the paper.)

From **Horace C. Ruggles,** Amityville, N.Y.: "My wife and I sure enjoyed the 45th get-together at Chatham Bars Inn in June — seeing so many folks. We had a visit with **Austin Kelley** and his wife at Metropolitan Museum of Modern Art in early November. Needless to say we did get a kick at the homecoming following the reunion." . . . From **Leonard Remmington,** Franklin, Mass.: "Retired but active as a consultant." . . . From **Ben Richardson,** Connecticut: "Still am enjoying the challenging pastime of research in that portion of history that deals with people past and present, mostly the former. Have a new title — great-grandfather (a ribbon with two bars ie. two great-grandsons). Cheerio." . . . **Whitney Ashbridge** (Whit's address is "World"): "We bought a small motor home and spent much of the summer in Canada. Got as far west as Vancouver Island where I caught a 23 lbs.-plus salmon. Then east through the Canadian Rockies and finally to Prince Edward Island and Nova Scotia. Over 17,000 miles since April; not counting eight weeks in Scandanavia." . . . **Harold J. Ryan,** New York, I think: "Shortly after the 45th Reunion I got a staph infection in my bad left hip requiring removal of the top of the femur. In the hospital for five months and finally have learned to walk again with a cane and get around fairly well, but have given up most of my work except occasional consulting jobs. Still thinking of the fun at the reunion and look forward to 1976!"

Charles C. Keniston: "Retired, 1967, after 43 years with Lever Brothers Co. (soap, etc.); traveled often around the world. As volunteer for International Executive Service Corps, four months assignment to advise and assist in start up of soap plant in Thailand." . . . **Sargent Graves,** State of Washington: "After a delayed retirement last December, my wife and I enjoyed a circle Pacific Trip that included Taiwan, Malasia, Australia and New Zealand. A few months after returning I stopped into the vitro office where I had been working and found an excess of work piling up. So now I'm again working and thankful that my health is such that I can enjoy it." . . . **Arthur C. Fuller:** "I've just finished cleaning the swimming pool for the last swim of the year. Water temperature, 56° F., air 50° F. here in San Diego, Calif. Hopefully, it won't go more than ten degrees lower for the balance of the winter. Already, the nearby mountains have had some snow, and skis are replacing surf-boards on car tops. I shiver to think of the rough New England winter that you are expecting."

Yes, this was a great pre-Christmas way to write class notes and my special thanks to all the contributors — while I head out before the storm. Cheerio! — **George Warren Smith,** Secretary, P. O. Box 506, Pidgeon Cove, Mass. 01966

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One of the many good things about Christmas is that, along with the welcome greetings, it often brings us some news of distant friends. That is especially pleasing to a class secretary. **Dick Cheney** tells me that he is keeping busy "on a relaxed basis" with three paying clients and considerable community service work. (After the schedule Dick has maintained all these years, that is his idea of relaxation.) He writes also, "My newly-acquired two beautiful daughters and five grandchildren are making life very bright for me. We are hoping for another European trip next year." Grandchildren are a new experience for Dick, but most of us know just how he feels. As this is written, shortly before Christmas, we are waiting for my daughter and son-in-law to arrive from Atlanta with the two little boys, five and three, who will brighten up our house and fill it with disingenuous affection.

Erik Hofman writes from Mallorca that he and Tibby have been staying close to home and have nothing new to report. That's not characteristic of Erik, and I hope to have further reports in a later issue. . . . **Ray Hibbert** helps to make up for Erik with a long, newsy letter accompanying his holiday greetings. Ray, along with **Dike Arnold** and **Bud Fisher,** visited **Bill Taggart** and report that Bill is making great progress in recovery from the stroke he suffered early in 1974. He is now at home in Belmont, and while still in a wheel chair, he is in the best of spirits, Ray reports, and anxious to correspond with classmates — including matters concerning his duties as Estate Secretary for the class. Dike has agreed to be reunion chairman for our 50th in 1977, filling the job that **Bob Bonnar** and **Glenn Jackson** managed so successfully for so many years. The general feeling at the 45th at Bald Peak was that we preferred to get together away from Cambridge for a couple of days before the general alumni celebration at Cambridge, and Dike will check available locations. The preliminary thinking leans toward Cape Cod, but Dike and the Committee have open minds and would welcome any ideas from classmates. Dike's address is 14 White Oak Road, Wellesley Hills, Mass. 02181.

Bud Fisher is working hard to realize the goal of at least a $500,000 50th Anniversary Class Gift, but the stock market has not been very cooperative. Perhaps there are one or two among us who were wise enough to shift into money-market instruments a couple of years ago, and generous enough to share the good fortune with the Institute. Ray also tells me that this past fall, he and Zella spent two nights with Rusty and **Judas Priest;** Judas retired over a year ago from Manson Neilan and is enjoying retirement. He plays tennis two or three times a week. . . . In November, Ray and Zella spent a week-end with Mollie and **Jim Lyles,** who were planning a Thanksgiving visit to their daughter Sallie and family in Rochester. Both Mollie and Jim are deeply involved in the Canaan (Conn.) Historical Society activities, and Jim keeps adding to his collection of antique hand tools. As for **Ray Hibbert,** himself, he is continuing his sales agency business in New Canaan, with no plans yet for retirement. He and Zella had a week in Bermuda this past fall, and a week in Vermont. . . . **Frank Kear** writes that after dissolving his telecommunications consulting business in 1972, he has recently joined A. D. Ring & Associates, a Washington consulting firm and former competitor. Frank has four children and seven grandchildren, and he reports that all goes well.

James E. Forbes, who received his master's degree from M.I.T. in 1927 and was affiliated with our class, died on November 18 last, in Honolulu. He has been a professor of aeronautical engineering at M.I.T., with time out to serve as Lieut. Cdr. in the navy from 1942 to 1946, and later worked at the Institute's Instrumentation Laboratory, from which he retired in 1968. His wife had died in 1967, after a 38-year marriage. — **Joseph H. Melhado,** Secretary, 24 Rodney Road, Scarsdale, N.Y. 10583

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Those of you who attended the 25 Year Reunion back in June, 1953, may recall the large class banner that was made for the occasion and displayed at each of the several functions. The banner was last used in the group picture on the steps of Walker Memorial. Then the mystery! No one has seen it since; no one seems to know what happened to it. The most prevalent theory is that some thoughtful individual(s) assumed responsibility for its safekeeping. We would like to locate the banner and have it for use at the 50th in 1978. If you have any information whatever please write.

The New Jersey Public Health Association Newsletter for June 1974 carried the following item relative to **Roberta (Lovely) Halligan:** "Not long ago Mrs. Roberta Halligan, treasurer of the N.J.P.H. Association,

was cited by the Essex County Health Officers Association for distinguished service in the field of public health. It was a well deserved honor for the lady health officer that everybody seems to know. Roberta, who lives at 36 Passaic Avenue, Roseland, can point with pride to a career as a health officer and her leadership activities in health organizations. It was Roberta on the platform participating at the annual state health conference, side by side with the governor, when Ken Jones was awarded the Frank J. Osborne award. Roberta received a bachelor of science degree in Public Health from M.I.T. and became the public health laboratory director in Montclair in 1928. In 1959 she became the Caldwell health officer. Later she became Essex Fells health officer and now serves as a member of her home-town board of health. She is past president of the New Jersey Health Officers Association and the Essex County Health Officers Association and still is active in both organizations, holding the post of secretary-treasurer in the latter organization." . . . **Bill Hall** was a coauthor of a highly informative paper on "Detection and Tracking Systems: An Historical Overview" that appeared in the fall, 1974 issue of *Electronic Progress,* a Raytheon Company publication. Until his retirement Bill was a consulting scientist and director of development engineering at Raytheon. He joined the company in 1941.

In a note to Frannie and **Jim Donovan, Walter Nock** reports that he has made a very considerable recovery both from his heart attack of last year and a continuing severe arthritic condition. He gives his wife, Lela, all the credit for the progress he has made. . . . A brief note from **Fritz Rutherford** says that he is looking forward to a possible mini class reunion in Mexico City, Mexico. He is still working hard on golf course and civic affairs. Last summer he and wife Jo took a horse-drawn covered wagon trip in the Grand Tetons in Wyoming. . . . **Vic Decorte** writes: "Finally, we can rest a little since our apartment is almost fixed up. It is quite a job to settle in the U.S.A. after an absence of forty years! We still have some red tape to deal with. Hope to hear from classmates in this area." The Decortes' new address is: Ocean Club, Apt. 1109, 4020 Galt Ocean Drive, Ft. Lauderdale, Florida 33306. . . . **Mary Manley** says: "Merely an observation: In 1924-25 I stayed at M.I.T. about ten days less than the academic year, but oh the lovely mileage I have had since from those few short months!"

We are sorry to learn that **Ed Petzold's** wife, Carolyn, died last August in Camden, Maine. Ed refers to her as his "loyal friend and companion of 44 years." This winter Ed plans to be in Paris, Rome, and the United Kingdom for visits to each of his three sisters. Judith (Mrs. **Benjamin F.) Miller** was in Boston on December 6, 1974 for the opening day of an exhibit of Ben's literary work at the Francis A. Countway Library, Harvard Medical School, 10 Shattuck St., Boston. The exhibit contains scientific papers, books, manuscripts and poems written by Ben during his lifetime. Three of the books were published after his death in 1971. We hope that many of you will have the opportunity to see the exhibit which will be open until the end of May, 1975 — **Walter J. Smith,** Secretary, 37 Dix Street, Winchester, Mass. 01890

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John G. Sullivan writes, "Sorry to have missed our recent 45th Reunion. My wife, Rita and I enjoy life here on Cape Cod, despite our over-inflated golf scores. Our activities include volunteer work at Cape Cod Hospital, numerous community activities, bridge, swimming (during warm weather only) and beach walking which keeps us in trim." . . . **Nick Stathis** has retired and lives in Stuart, Fla. . . . **Frederic A. Celler** of France, having reached the mandatory age of 65, has retired as president of AMP de France as of September 1, 1974, which post he occupied since 1965. He has now become a consultant to the company. He and his wife Marjorie are well and enjoying their well earned leisure.

Ezra C. Hill writes, "Since my recent retirement from General Electric Co., I have been doing some engineering consulting for the company in the Specialty Transformer Department. I find plenty of work to do, beside doing consulting. Presently I am working on a family record book." . . . **Stephen N. Dilworth** and his new wife Myn, whom he was courting at the reunion, have just returned from an extensive tour of the U.S. and Canada covering 6,000 miles. The newlyweds will be sailing on the *Statendam* on December 20 from Fort Lauderdale, Fla. for a cruise. Upon their return, they will spend a month on the East Coast (Fort Lauderdale). Since your secretary and his wife Helen will be in Fort Lauderdale during their stay, it is hoped and expected that there will be many pleasurable social contacts with them. . . . **Thomas H. Speller** writes, "Thank you for the birthday greetings together with a fine photograph taken last June. It was a great reunion and this is a valued souvenir. Best regards to all." . . . **William F. Jenkins** writes, "Since my retirement in 1971 from H. L. and P. Co. after 42 years of service, I have been busy with one project or another. Currently, I am engaged in the development of 20 acres of land for my next homesite. The roads, the well, and the septic tank system have all been installed. But the most unique part of my project is an "all electric" barn which I have planned to build, which may be the world's *first*. If any other '29er owns an "all electric" barn, please let him contact me and we'll swap lies together. Thanks for the birthday card."

Marshall S. David, who attended the 45th Reunion with his wife Dot, writes, "Many thanks for your birthday greetings and the excellent pictures which you had taken at Chatham Bars Inn. We enjoyed seeing all the gang at the reunion. Our son and family spent their vacation with us in August, and Thanksgiving in November. In the meantime, latter part of October, I was rushed to the Cape Cod Hospital by ambulance at 1:00 a. m. After two weeks, I was transferred to the New England Medical Center for another week. I feel all right now and go for periodic checkups. For activities, every Sunday I go to the beach with neighbors to get my quota of oysters, soft and hard shell clams, and scallops. During the week I get pine-needles for my lawn and sea weed for my roses. Dot's mother, who is 92, has created some problems. We may have to put her in a nursing home. Hope you are all well and enjoying life in New Hampshire. Did you know that old David Homestead was in Amherst? Best wishes for all." . . . Since his retirement from a family owned contracting firm, **George J. Burke** is enjoying the easy life and is doing as much traveling as he can. . . . **Cub Clark** writes, "Thanks for the birthday card. I am now retired, though I do some occasional consulting work at the Denominator Co. of Woodbury, Conn., makers of tally counters. When the boss is away, I am called upon to take over the administration of the business temporarily, writing checks, handle inquiries, etc. In my leisure hours, I play as much golf as possible, and have succeeded to get my handicap down to 23. The latest addition to the number of grandchildren came in October, a girl — a grandmother's love — making the total three to date. I have given up playing my violin, but still sing in the church choir, having been graduated to a baritone. Having been conscripted to **Frank Mead**'s 50th Reunion Gift Committee some of you fellows may hear from me."

Eric A. Bianchi writes, "Dear Karnig: Delighted to hear from you again and for the same reason as last year — glad to be around to receive those birthday greetings. Thank you for the pictures, too, which will serve to remind us of a good reunion." . . . We recently had a fine visit with Joan and **Wally Gale** at their Melvin Village home; the foliage was superb. We expect to be in [looks like Tequerta?] again — this time from January 10 to March 1, 1975. Kindest regards and best wishes to all." . . . A note comes from **Amasa G. Smith** that he is starting his fourth year of retirement but fortunately and by choice his days are filled with all kinds of activities, most of it having to do with charitable and community affairs. He has an office in downtown Birmingham and this year, two of his friends who recently retired, one chairman of the board of a local national bank and the second who managed all the Sears stores in the state, have joined him. Mace serves on the boards of: Red Cross, Boy Scouts, Girl Scouts, Y.M.C.A., and United Way Community Funds. He still serves on the boards of a bank, National Woodworks Corp. and Blue Cross and Blue Shield. "I still manage to get in two or three rounds of golf", he continues. "Sorry we had to miss the 45th Reunion. Thanks for the good work you are doing for the class, and your notes in the *Review* are always good. Best wishes to all." . . . A note from **Walter F. Burke** reveals that he has retired since October, 1973, after 30 years of service with McDonnell-Douglas Corp. He was president of McDonnell-Douglas Astronautics Co. of Huntington Beach, Calif, and St. Louis, Mo. For the past ten years he was responsible for the design and the whole programming of Mercury space craft "Gemini" and the Skylab, with 100% success. Since his retirement Walter has established his own consulting business in Newport Beach, Calif. Having been a licensed pilot, he flies his own twin Beech-Baron all over the U.S. His wife Pat has put a P.S. on the report, noting that Walter has never missed one day in school or work since he entered kindergarten in Roxbury, Mass., and all through M.I.T., University of Michigan, and 30 years at McDonnell-Douglas. This, I am sure must be a *first* among our class members, if not in the entire Alumni Association. Reading about such a record, the question: didn't he ever get sick?

Anthony J. Perry, who was present at our 40th Reunion, has sent his regrets for his inability to attend our recent 45th one;

but promises to attend our big 50th Reunion. Though he has been retired from the Army Corps of Engineers for some time, he does some consulting. The latest project he has been working on is a hydroelectric survey in Bolivia sponsored by the U.N. He sends his best wishes to all his friends. . . . A special issue of AEG headlines publication of G.E. announces the retirement of **Samuel J. Levine** after 46 years of service with the company. His first affiliation with G.E. was in 1928 as a Co-op student. One of the officials of the company, while paying tribute, stated that Sam's outstanding career has been marked by consistent significant contributions to General Electric business success. His most recent responsibility has been to solve group-wide problems. He has the technical ability, the leadership, the experience and the toughness which spells success of every problem he tackles. After joining G.E., Sam earned his graduate and undergraduate degrees in electrical engineering and enrolled in the company's ABC Course in Engineering, completing it in three years. One of his earliest applications was the Air Conditioning Division where he rose to top level management position. In 1956, he joined the Aircraft Nuclear Propulsion Department and became manager of its Idaho Testing Station. Later, he headed the Engineering Operation for Small Aircraft Engine Department in Lynn, Mass. In 1969, he was named general manager of the Marine and Industrial Department. Sam holds ten patents and is a member of the American Society of Mechanical Engineers and the American Nuclear Society. — **Karnig S. Dinjian,** Secretary, 6000 N. Ocean Blvd, Apt 14E, Fort Lauderdale, Fla. 33308

Mario V. Caputo, '31, lost his class ring in the summer of 1933 at Revere Beach. Now, 41 years later, it has been found buried deep in the sands by William P. Mills of Rockport as he was looking for old coins with a metal detector. Mr. Caputo's name was engraved in the ring; he was located through the records at M.I.T.

It was particularly gratifying for Mr. Caputo to have the ring returned to him because it had been a gift from his late sister, Philomena R. Caputo, who was also an M.I.T. graduate ('23).

After winning a competitive scholarship, Mr. Caputo attended M.I.T. for two years as a special student in the Department of Architecture. He is now a retired architect living in Belmont. "I am still astonished," he said, "that the ring which presumably was lost forever has been found."

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Supplementing the item about **Olin Stephens** in the December notes, we have a clipping at hand from the *Boston Globe* concerning his receipt of the Mignon Trophy of the Aluminum Association. This award derives its name from a 40-foot steam yacht which was the first aluminum-hulled boat and which was built in France in 1892. The award is presented as a symbol of excellence in yacht design. At the time he received the award, Olin commented on the fact that aluminum seems to be taking over that part of boat construction that once was reserved to wood, and said that it is easier to get a good aluminum boat built today than it is to get a good wooden boat built. He predicted, however, that aluminum would not replace fiberglass for the smaller boats. He said that when welding the skin of an aluminum boat, it is "difficult to keep it fair" if the boat is not large enough. . . . **Donald McAndrew** has initiated, promoted and developed a government housing project for 195 medium income elderly persons in Baton Rouge, La. The project comprises a 14-story building which cost upwards of 3 million dollars. The project was co-sponsored by the Catholic diocese and the First Presbyterian Church in Baton Rouge

Bob Sidur has retired from Western Electric but continues to engage in a number of business activities that keep him busy. He is the trustee of several large trusts and numerous smaller ones, as well as president of the Nan Realty Corporation. He does consulting work in the communication engineering field, as well as for banks in connection with investments for trusts. In addition to his business activities he has a long list of hobbies including, in addition to the more conventional hobbies, navigational aids, sound and optics. The Sidurs live in Chatham, New Jersey. . . . **Jim Saunders** retired in 1970 as principal of the Northbridge Junior-Senior High School in Whitinsville, Mass. Jim had been at Northbridge for 38 years, first as a biology teacher, then as an assistant principal and finally during the last ten years before his retirement as principal. Jim's principal hobby is amateur radio, call letters W1BDV. He has been a member of the American Radio Relay League for more than 50 years. He also has an Airstream trailer in which he travels. The Saunders have two children and seven grandchildren who live on the same street with them. . . . We also have a delayed notice that **Bill MacKusick** retired from Goodyear Tire & Rubber Co. in 1970 after 40 years. Bill's field involved the design of off-the-road tires. He did considerable traveling, visiting manufacturers of earth-moving equipment and working with their engineers on tire recommendations. Jim's headquarters is in Akron, but he has a home in Maine where he receives visits during the summer from his three children and eight grandchildren.

We have at hand a clipping that **Jules Larrivee** died on September 27, 1974 in Corvallis, Oregon. After graduating from M.I.T. Jules worked as an astronomer at the U.S. Naval Observatory in Washington. Subsequently he joined the faculty of the University of Vermont and later of Worcester Polytechnic Institute. In 1963 he moved to Oregon as Professor of Mathematics at Oregon State University in Corvallis, from which position he retired in 1971. He leaves a son, Jules Palmer Larrivee, who is living in Switzerland — **Gordon K. Lister,** Secretary, 530 Fifth Avenue, New York, N.Y. 10036

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It was with sorrow that I learned of the deaths of **Harlan E. Glidden** on October 22, 1974, and **W. Jim Roberts** in September, 1974. Our deepest sympathy to their families.

Word from **Howard Huntress** says that he retired in April 1974 and now is writing, gardening and relaxing only a little. His youngest son, Gordon, is a dentist on the

staff of the Cincinnati General Hospital. He and his wife are about to produce Howard's third grandchild. . . . Honored by the City Club of New York recently for his contributions toward making New York City a "world city" was **Soichi Kawazoe,** executive vice president, the Nissen Motor Corporation. Sorry to say that is all the news that I have been able to gather in the last month. If you would like to have more, how about dropping one of us a line bringing us up to date on your activities. — **Edwin S. Worden,** Secretary, 35 Minute Man Ave., Westport, Conn. 06880; **Ben W. Steverman,** Assistant Secretary, 260 Morrison Dr., Pittsburgh, Penn. 15216; **John R. Swanton,** Assistant Secretary, 27 George St., Newton, Mass. 02158

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Don Whiston's recent note to the entire class roster, concerning our "43rd" at the New Deepene, Harrington Sound, Bermuda, the weekend of May 2 thru May 5 gives everyone a wonderful opportunity for a happy, healthy relaxing New Year's resolution to join the fun and festivities for four days and three nights. Don't forget the deadline — reservations must be in by March 31, 1975. . . . **Byron E. James** relates in a recent note that he reached the retirement plateau in August 1973, but remains as chairman of the executive committee of McQuay-Perfex, Inc., and the additional good news that all the family are well with one son and one daughter married and one youngster still in college. . . . **William S. Clark** and his wife Phyllis hope to come to the next class reunion according to his recent activities report, and advises that his son Bill is a senior at Carnegie Mellon, Pittsburgh and his daughter Laura a sophomore at Ohio State University.

Henry Rockwood, after 42 years of federal government, retired on December 27, 1974 to do some traveling and hopes to eventually locate in a milder climatic area. . . . **Rolf Eliassen** reports with the following news; "I have taken early retirement as Professor of Environmental Engineering (Emeritus) at Stanford University. This has been a great experience for me as we have built the curriculum from scratch in 1961 to 84 students this year in our graduate environmental engineering program. I am still active in consulting as Chairman of the Board of Mecalf & Eddy Engineers and am a member of the General Advisory Committee of the Energy Research & Development Agency (E.R.D.A.) as I was on the Atomic Energy Commission." . . . **Marjorie Fuller** was among those enthusiastic supporters in the recent drive of sailing activities. . . . **Carlos E. Burnett** retired from R.C.A. Corp. on May 1, 1974 after almost 41 years of service and now intends "enjoying life doing many things I've put off many years."

Lawrence A. Ludwig retired from Mobil Research & Development Corporation on June 1, 1974 to start building his "dream house" but returned to work as a consultant on September 15, so that work on the new home is confined to week-ends, with no predictions on the completion date. . . . **George W. Muller, Jr.,** retired seven years ago from the National Sugar Refining Company and this past April retired from the Kerr-McGee Company, is now engaged in his favorite hobby of gardening and a bit of traveling to California to visit his children. . . . Your Secretary is in receipt of a pleasant notice from the M.I.T. Club of Mexico City announcing the 27th M.I.T. Fiesta in Mexico. March 13-15, 1975, with Luis A. Ferre, '24, President of M.I.T. Alumni Association and former Governor of Puerto Rico as guest of honor.

Word has been received of the deaths of **Charles B. Bradley** on August 9, 1974 and **Roger J. Zampell** on October 21, 1974. Our deepest sympathy to their respective families — **John W. Flatley,** Secretary, 6652 - 32nd Street, N.W., Washington, D.C. 20015

33

Enough on the walrus, for now; top billing this time goes to **Bill Baur,** traveller extraordinary (just so they speak Deutsch where he visits.) The Baurs took a trip to the area around southwest Germany, where Bill and Claire were born and raised. Remember that Deutsch is spoken in Austria, and eastern Schweiz. They have a few complaints about what a dollar will buy now, as opposed to a few years ago. I quote, "where we used to change dollars by dividing by 2.5, they now divide by 4.2." Let's all guess why. Apparently, inflation is about as severe there as it is at home.

Bill has a proposal that might be of interest, concerning the Mexico City Club Fiesta. He suggests that we make up a rather large party of classmates, take in the Fiesta, and all live at the same hotel. This plan has a great deal of merit, and it can be done, but, I fear not this coming Fiesta. As I write this immortal tome, it is late December, and the February *Review* will appear late in that month, and, the Fiesta takes place within three weeks after that. Bill, I suggest that we do it in March, 1976, and make our plans early. Inasmuch as this is not official class business, I feel that I will step on no toes if I appoint you, Bill, as Chairman of the 1976 Fiesta committee, class of 1933. Was it not the class of 1932 that did just this, and they had more than 30 classmates in attendance?

Bill has a short report from a meeting of the M.I.T. Club of central Florida. He met **Maurice Brashears** there. Maurice does consulting work, in Tampa, in ground water geology, and doing well. However, Maurice, though embarrassed by not having written to me, has yet to do so. Many thanks for thinking of us, Bill and Claire. I dunno what I would do without you.

I have a rather fine letter from one of our better vice presidents, **Courtenay Marshall,** who took a trip to the near east. It appears that the trip was to have included an extended visit to the Black Sea. But the Cypress situation precluded that. So, they flew from Athens to London, and visited the Lake Country and the Cotswolds; spending a week in each, and apparently had a great time. They were there just at election time, and heard Prime Minister Wilson describing England as a sort of local Paraiso; much better than our U.S.A. They had planned to fly from England to Malta after that, but ran against a strike by employees of British Airways. This happened to them once before so they are now off that airline, completely. In 1954, Leona and I took a cruise on the old Coronia, got as far as Athens and ran into the earlier Cypress trouble, and had to spend some time at Dubrovnik, Yugoslavia, and extra days at Venice. Many thanks, Court.; see you Mexico City come March? Hope so. . . . We have a short one from **Cal Mohr,** written after a visit to his old home town, Rochester, N.Y. Cal made a few phone calls, found that **Bob Smith** was tending his booth at an Antique show; **Walt Swanton** was on his way to Roumania, by air, on a vacation. Walt has purchased a piece of land near his present home, and plans to build his retirement home on it. . . . **Dave Babcock** retired from Eastman Kodak in July, and is busily doing his own home repairs, to make a try at restoring it to its original condition. They have a high school exchange student from Germany living with them, and, their daughter, the same age, is doing likewise in Germany. Now, that note is rather terse, but, look at what he made out of it. Lotsa news in condensed form. Many thanks, Cal, and best to Jean.

We have the first of the usual family Christmas letters from Marcia and **Red Payne,** also Rochester. These family Christmas letters are full of information, but written as a recap of the family year, and it is real tough to paraphrase. All I can do is take out bits and pieces which have class news value. Red and Marcia have already sold their Mill Road house, and spent a lot of time and effort cleaning out the old home. They visited daughter France last Christmas in California, before the kids moved to Tulsa. Children all over, or so it seems; Marcia(Jr) lives in Weedsport N.Y., and has three children, plus one stepchild. France lives in Tulsa and has one child plus one sort of expected; daughter Nancy seems to have three, though where is not clear; Red took the two biggest grandsons fishing via Trailer, in the Adirondacks last spring. Then the two (Marcia and Red) spent from November 73 to May 74 in the trailer, visiting in North Carolina, then to Georgia, Florida, California, Yucatan, Mexico, back to Texas (Uncle Lander, 81), East Texas, Natchez, Kentucky, Ohio, and home. The trailer is named "Paynestaker", not bad! Just to keep from being bored, Red and Marcia are now planning a European saga via VW Beetle: England, France, Spain, Portugal, then to North Africa, to settle down where it is warm for a bit. Soon after that long trailer trip, Marcia was made a Life Member of the Board, "teen-age diplomats" for her 18 years of service and never ending devotion to the exchange student program in Rochester. By golly, Marcia and Red, we sure appreciate getting your "family year" story, and we thank you no end.

From **Ellery Clark** and Louise, we have a card (Christmas) of the Virgin Islands, but not mailed there. Ellery is presently with Rockwell International, on the B1 Bomber, but will retire on or before May 1975, then travel in the 27-ft. Airstream trailer; where, undetermined. This summer they will travel through Canada, west to east, and New England. This he got on one card, and it is welcome. Thanks a whole lot, Ellery. . . . In announcing new directors of Aerospace, we find that they have have made our own **Dick Morse** one of them; a rather distinguished group. Dick, for some time has been president of M.I.T.'s Development Foundation, and has long been a senior lecturer at the Sloan School. Our congratulations, Dick, and more power to y'all. . . . **Carl Swanson,** in an Alumni Fund capsule, reminds us that he is retired and living in Newtown, Conn.

Many thanks, Carl. . . . **Phil Cook,** in another Fund capsule, wonders how the time flies, having retired four years ago, and then becoming so busy at gardening, traveling, sailing, and other pursuits that he can't figure out how he found time to work all those years, when there is so much to do after retiring. Well, Phil, you are one of the fortunate of us. I have known men who "knoweth not" how to retire. Thanks for your message. . . . Another busy retiree is **Max Millard,** who has about the same message as just above here, with an added feature: he is trying to conserve in the face of inflation.

Dave Smith writes from Drexel University, that he too is retired, and has just published a co-authored book, *Systems Engineering and Management.* He is expecting his second grandchild soon. Second or twenty-second, they are all thrilling, Dave. Thanks for the note. . . . **Stan Walters** says he is busy getting firewood, and paying his property tax bills. After reassessment he says that it is getting expensive living in New Hampshire. Mebbe you ought to try a few that I can name, Stan. Personally, New Hampshire is still the cheapest in any list that I can find. Keep sending to the Alumni Fund, and you can deduct that much anyway. Thanks, Stan. I did get a large one from you earlier this year. . . . Well, well, a card from Roz and **Ellis Littmann,** from Sydney, Australia, of the controversial opera house, that some think looks like a wind-catching experiment. Ellis' message is mostly personal, but he did think of us, no? I expect a longer message when the Littmanns return.

That's all the news for this time, and I am reminded of some corporations who had a backlog of orders, and now do not. I have no backlog of letters from the faithful, and brother, I can't write a column without news, as I am not allowed to improvise. No address changes this time (which I do not believe), but we do have a notice of one of ours passing on: **Laurence F. Brown,** of Framingham, passed away in June of this year, though we know about it in December. I have written to Larry's widow, as some of you might also wish to do; Larry had many friends, and we all extend our sympathy to the survivors.

I am going to the Fiesta, and hope more of you are. — **Warren J. Henderson,** 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

34

Let me start with a nice long letter from **Phil Kron.** It includes not only news about himself and his wife, but also other classmates he has been seeing. Phil writes: "Ellie and I are back in Florida for the winter after spending an enjoyable summer at Owasco Lake (one of New York State's Finger Lakes). I'm trying to do a little consulting work in the purchasing field, but not too much to interfere with any golf schedule. My card is enclosed. It gives summer and winter addresses (September - May, Boca Raton; June - August, Moravia, N.Y.).

"Sorry we had to miss the 40th Reunion but we were just in the process of moving north, for the summer and the extra miles to Cape Cod were just too much for us, much as we would have enjoyed being with so many of you old friends. Ellie and I had dinner a couple of weeks ago with **Harold Thayer** and Bess at the Ocean Club in Del Ray Beach. They were down for a week's vacation and bought an apartment near the club. It's still under construction and should be ready some time next year. We had a delightful evening reminiscing. We hope to see more of them in the future when they can spend more time in this area. Harold is still very busy as chairman of the board and chief executive officer of Mallinkrodt Chemical.

"We saw **Bill Mills** and his wife a little over a year ago in St. Petersburg. Had a wonderful social hour at their magnificent home which must be one of the show places of the entire city. Bill is still very active in the construction business and has been given practically every civic award available in the Tampa-St. Petersburg area. He can point with pride to many of the finest and largest building projects in the area which were built by his company. He seemed extremely happy to have his son in the business with him now.

"It was a shock to read about **Bob Mann**'s death in the notes. He was a fraternity brother and a fine fellow, and although I haven't seen much of him in recent years, I'll always remember the good times we had together on Bay State Road." Phil closes with the comment "when you get a new class agent I'll send him my records — a lot have accumulated in the 12 years I've had the job. It is interesting to note that my oldest son, Philip C. has just been appointed class agent for his class ('60) of Dartmouth College. So you see it runs in the family!" Thanks, Phil, for the newsy letter — they're the kind that make life easy for George and me — maybe yours will inspire some others.

Also from Boca Raton but on a more somber note is a letter from his wife Phyllis concerning the sudden death of **Herbert W. McKeague** last September. They had moved to Florida two years previously when Herb retired early from the Motor Wheel Corporation in Lansing, Mich. He had been an executive of the subsidiary of Goodyear Corp. for 28 years. Mrs. McKeague adds that they consider Lansing their home, as that is where their two children grew up. A son, David, is now a lawyer in Lansing, and a daughter, Peggy, a paralegal in San Francisco. Both graduated from the University of Michigan and David went on to the University of Michigan Law School. For all the class I would express our sympathy to Mrs. McKeague and her family on their loss. I would also like to add my appreciation for the time she took, under difficult circumstances, to write in the detail she did.

Another loss to the class is the death of **Charles H. Mapes** in July 1974. He was with the Norfolk Naval Shipyard and word of his passing came through the Alumni Office. Again, I can only extend sympathy from all of us to his family.

A Christmas note from Winnie and **Ted Taylor** bore the sad news that their daughter Priscilla had been killed in a plane crash in Colorado in July. Her husband was piloting the plane and they were returning from a vacation in Maine with Ted and Winnie. He was (in December) finally home from the hospital and their little son nearly completely recovered. Winnie adds "we are trying to cheer up as Warren (who seemed on the way to confirmed bachelorhood — RMF) is to be married on Christmas. Then we shall leave in January for Mexico where a friend has offered us her apartment." This news about Priscilla was a real shock as we have known both children since their childhood.

All the Alumni Fund notes this month bring news of retirements — some recent, and some several years back. **Richard F. Miller** writes "After two years as an instructor in the metallurgy department of Yale University and 35 years with the research department of U.S. Steel in Pittsburgh, I retired in 1970 and moved from Pittsburgh to Winter Park, Fla. Have two sons and three granddaughters." . . . **James M. Farrin** notes "I have retired after 36 years in the navy in Ship Design, Shipbuilding, and ship repair, followed by eight years with Airojet-General Corp. working in shipbuilding and ship design in the surface effect ship and air cushion vehicle area. (Assistant Manager, Surface Effect Ships Division)". I am always grateful for these notes and don't want to quibble but as I wrote this I was doing some mental arithmetic — 36 plus eight is 44, added to 1934 comes out 1978 — and we aren't quite there yet! Jim — would you like to tell us which calendar you're working with?

Finally, from **Edward E. Pierce Jr.,** "Retired year round at the seashore. Active in church and U.S. Power Squadron. Our home becomes a free boarding house for family and friends each summer. We rent houseboats on the Chesapeake bay." — **Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631; **George G. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C., 20016

35

Plans are fast developing for our 40th Reunion. M.I.T. Night at the Pops will start things off on Thursday June 5, while Friday June 6 is Alumni Day. Our class meeting will be held Saturday morning followed by an interesting program through the afternoon and culminating in our Banquet that evening. Sunday has been set aside for a selection of activities including tours and golf. We also hope to have enough oarsmen back to put one or two crews on the river for a very short spin. Committee co-chairmen **Rufus Applegarth** and **Ned Collins** are organizing all sorts of committees to handle the details which you will be learning about through the mail. Plan now to set that long weekend aside, bring your wife and join us in Cambridge. The housing is provided for us by M.I.T. Now also is the time to write or telephone that '35er you haven't seen for so long and make joint plans. Your 40th only comes once and this is the year. Don't let it pass you by. Be there! One who will be there is **Ed Taubman** whose letter follows: "Have just finished reading the October/November *Technology Review* and, whenever I see a bunch of letters, my conscience pricks me to write (about once every 5 years). Am looking forward to the 40th next June. Since I don't remember where I left my life story in my last epistle, I'll start about six years ago in 1968 when I sold my retail business of auto supplies and hard goods, but retained the properties we (my brother and I) had built to house our stores. We then started building additional commercial properties, such as strip shopping centers and warehouses, until the recent money crunch put a moratorium on such ac-

tivities. Real estate is nowhere near as grinding an activity as retail stores, so I really feel retired when I work only 5 days a week and even then sleeping late and arriving at the office about 11:00 a.m. As a result, my wife and I have been doing a lot of world traveling: Japan and the Orient, East Africa, Israel, Greece, Italy, France, Hawaii, etc. In addition, it seems as if all the preparatory hard work of the past 40 years all of a sudden jelled to spew out monetary results to put me in the economic royalist category. It is pleasant to suddenly have disposable income nicely in excess of necessities. As a result, I've been able to participate in community and philanthropic activities to do some good, as well as pamper myself. My hobbies have expanded from philately to yachting and silver coin and plate collecting. In addition, my children problems appear to have been solved so that I now feel I am a very fortunate man. Right now, I am still riding on Cloud 9 having just given myself a scrumptious 60th birthday party on November 19. By way of explanation, during my undergraduate days I would skip lunch to save up 20 bucks; $5 would buy a round trip weekend excursion trip to New York City, and $15 would pay for dinner and dancing at the Hotel Roosevelt to dance to Guy Lombardo. My cherished dream then was to employ him someday for my own party. Well — this was it. I kept it a secret — even from my wife — and merely described it in the invitations as a dinner dance to commiserate my 60th birthday. Guests, besides my relatives, were all the friends I could locate whom I had been close to from grammar school days up to the present, and I found a total of 180 who could attend. Among these were Irv Kusinitz, '34, Roger White, '24, Ed Chin Park, '40, Paul Lappe, '34, **Carl Smith** and Frank Libman, '40. The widows of **Bill Abramowitz** and Henry Kawecki, '34, unfortunately couldn't make it, and neither could Prof. (emeritus) L. F. Hamilton who once, regretfully, had to boot me out of the dorms for multitudinous infractions and later became good friends at reunions. Well — I had anticipated that the surprise of Guy Lombardo walking in would cause quite a ripple. I was completely astounded by the actual reaction of my guests. About the best description I can give is that they just exploded. This and the feeling of warmth it generated made it a truly unforgetable evening I will treasure for the rest of my life. And my guests kept on repeating the same. I hope this isn't my swan song, but should it prove to be, I could do a lot worse. Now, to you members of the Class of 1935 who have never or only occasionally attended a five year reunion, let me urge you to make a real effort to come back to Tech in June. Even if you have to "skip lunch" to do so. While it is quite true that the approximate 500 men and women who graduated then consisting of frat, dorm and commuters could never have been 500 close chums, it still is quite true that we share the common heritage of having been the Class of '35 and brushed each other in many ways near and far. As such, we were part of each others lives more or less for those four years and owe each other the opportunity to meet and reconstruct from memory the warm fellowship we had then and can have again for an interval. I have just experienced this in the party I described, and can only tell you that the inner feeling is almost impossible to put into words. There is no question, also, that the degree of attainment, by individuals, monetarily, academically or professionally, no doubt varies all over the scale. Many of us may still be having mortgage payment problems, or perhaps be only part-way up the corporate ladder, etc, etc, but there is one thing we have all achieved equally — which is — we are all members of the Class of '35 and, as such, have contributed to this world what we were able. I guess what I am trying to say is that, if your past decisions not to attend reunions was based on the fact that you felt you had not yet achieved your goals, forget it. To those of us who came to reunions and who are coming to the 40th, the main goal was achieved when you graduated with us in June, 1935, and we'd like to see you again; in fact, one might say almost that you owe it to us. This also goes for the widows of 1935 who will read this. I realize that, if you do, some of it will be quite sad. However, I also think that the rewards of re-living former friendships and its attendant anecdotes will far outweigh the sadness. I was once very impressed by the eulogy of a friend whose funeral I attended when the clergyman stated that, whether or not one believes in hereafter, no one really dies whose memory is cherished by his friends or those who loved him." Many thanks, Ed, for sharing that party with us and your thoughts about our 40th and the importance of being there.

After that fabulous letter I am sorry to have to tell you about another '35er whom many of us knew so very well, but who will not be at our 40th: **Jack Orchard** died suddenly in November, 1974. Since 1970 he has been working on the Bi-Centennial. For a number of years prior to that he worked for the Department of Commerce where he received the Silver Medal award. To his wife, Helen, and their six children I extend our deepest sympathy. We will miss him.

Two short messages came through the Alumni Fund office: **Philip H. Rhodes** from Cincinnati says, "Same old job developing new and better additives for polymers." **Blake Mills** states, "I am in my 29th year as professor of mechanical engineering at the University of Washington." Now, whose conscience is going to be pricked into action. Write. — **Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

36

It is to be hoped that when you read these notes the New England states are covered with a deep blanket of "snowshoe-able" snow. . . . Meanwhile, the time lag being what it is, your secretary is taking time off from opening Christmas cards and wrapping gifts to write these brief notes. . . . The M.I.T. Press has announced the publication of *Magnetic and Electric Suspensions* of which **Philip Gilinson, Jr.** is one of the three authors. The trio played a major role in the development at the Draper Laboratory of suspension devices used in the navigational and guidance systems of the Apollo moon flight program and the monograph describes and analyzes the operating characteristics of these devices. . . . **Aldo Bagnulo** writes (with his contribution to the Alumni Fund) that after several years with regional planning and local enforcement agencies for water resources management since his retirement from the Army Corps of Engineers, he has recently joined Bechtel, Inc. as Manager of the Environmental Projects Office in Gaithersburg, Montgomery County, Md. . . . Similarly, **Robert Newman** reports that soon after these notes appear he will retire after 39 years with General Electric. His most recent responsibility has been as Manager of Corporate Strategic Planning Research, Corporate Executive Staff in Fairfield, Conn. . . . There is not much room on those return envelopes to the Alumni Fund and I would welcome hearing more from any of you. — **Alice H. Kimball,** Secretary, P. O. Box 31, West Hartland, Conn. 06091

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Duane Wood has assumed a new job as Sr. Vice President and President of Lockheed. He has been spending much time in the Middle East on marketing Lockheed's Tristar Air Craft. . . . **Matthew L. Rockwell** reports a change of address to 393 Fairview, Winnetka, Ill. 60093. . . . **James A. Newman** has been elected President of the Board of Trustees, The Phillips Exeter Academy. He also has moved to River Road, West Cornwall, Conn. 06796. . . . **David F. Tuttle** expects to teach at Stanford, in France January through June, 1975. Dave held a Fulbright lectureship in France during his 1954 sabbatical. He lectured in French. . . . To those of you who send out Christmas news letters, please send a copy of your last one to **Bob Thorson** or **Lester Klashman.** Your classmates would like to hear about you in future issues of *Technology Review*. — **Robert H. Thorson,** Secretary, 506 Riverside Ave. Medford, Mass. 02155; **Lester M. Klashman,** Assistant Secretary, 198 Maple St., Malden 02148

38

It is hard to write February notes just before Christmas, particularly when my office is being moved from the 23rd floor to the 22nd floor of 140 Broadway. The significance of this is that all sort of news items have been mislaid. I am however, using a 1975 appointment book that **Norm Leventhal** sent to me.

Dave Acker writes, "After having taken it easy for the past three years, I am now back at work as an independent consultant. I find it more enjoyable than being an employee." . . . **Bob Uddenberg,** who is president of Sheldon Jackson College was awarded an honorary Doctor and Laws Degree by Whitworth College last November. — **A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y. 10005

39

Upon return from my second trip to Europe, Africa, and the Middle East in three months, I found some news and Christmas cards to share with you this issue.

Ralph Wollett went to Moscow last April as U. S. delegate to the International Electrotechnical Commission, Committee on Electroacoustics. . . . Martha and **Cris Rosas** have had a most unusual recent ad-

venture. You may remember Cris owned and operated some whaling fleets and rendering works in Peru for many years. He and Martha were perfect hosts during several visits I made there during 1967-68. Now they have added a note to their Christmas card: "We left Peru because of the military regime. We live now in Costa Rica, Apartado #1310, San Pedro Montes de Oca."

Al Graffeo also is part-way through a deeply moving experience. For years Al had made his contribution to our country via the military and government services. Recently he gave away all his wealth and took the vows of poverty. He applied to his church for assignment within its organization and toward the betterment of mankind. His application was unfavorably considered. I suppose each of us would feel badly, at our age level, to find ourselves with zero material assets and no job. I have found a few words Al wrote inspiring: ". . . I need not tell you that our Lord, in His wisdom, sends us problems to solve in our own way. Each problem has its purpose and can be a stepping stone to a greater good. Thus, while I have a large problem now, I am still alive, in good health, and know we must continue to do His will . . ." If you'd drop him a line at 20 Sharon St., West Medford, Mass. 02155, I am sure Al would enjoy hearing from you.

On page 55 of the December 1, '74 *Boston Herald Traveler*, there is a three-column article about **Paul Stanton** who gave up the presidency of Pratt and Whitney and some overseas interests to buy the Falmouth Yacht Sales business. The article mentions that Paul is expert in cooking seafood but unfortunately did not mention the address we could use to call on him and check his expertise. Never mind. Paul will be calling on us one of these days in connection with an M.I.T. Fund drive and that might be a good time for each of us to get in a bit of "quid pro quo."

Pretty cards arrived from Sybil and **Bob Saunders** (Atlanta) and Alletta and **Bob Touzalin** (Creto, Ill.) and **Dave Bartlett** (Tulsa), and Dotie and **Bob Casselman** (Wellesley). Other greetings, now probably en route, will be waiting at home when we return from this trip, and I'll relay the news to you in the next issue. . . . After 28 years with Sperry Rand, **Robert L. Frank** commenced consulting in Electronic Systems, headquarters in Southfield, Mich. His three sons are all in college, one in business administration and two in computer science.

In the mail was a cordial note from the man we remember as Dean of Freshmen and "Man with a Fantastic Memory." I suppose you know Tom Pitre retired several years ago and he and Hester live now at Mease Manor, Dunedin, Fla. 33528. It would be just great for some of you to just take ten or 15 minutes to sit down and drop Pete a note. I'll be you'd be surprised at all the things he might remember and would include in his reply to you!

And from Nils and Janet Rosenberg, now of Seattle, but formerly with class of '40 at M.I.T. and Wellesley, comes this note: "Now that you are secretary of the Class of '39, the *Review* is worth the price just for reading your column . . ." Well, Nils, flattery will get you somewhere, even if it promotes a man from '40 into the column of '39. But there is a lesson in this, too; ie. what makes our column interesting is news about our associates and their adventures. So, when you take pen in hand to write to Al Graffeo and Tom Pitre, please don't forget to add me to your list. — **Hal Seykota,** Secretary 14650 Island Dr., Jacksonville Beach, Fla. 32250

40

The news in brief is that **Bob Lundgren** has been appointed Executive Vice President-Aministration of Detroit Edison. Bob has been with Detroit Edison since graduating from Tech. . . . **Jean L. Lewis** was honored by the New England Friends of the Jewish Theological Seminary at the National Community Service Award dinner in recognition of the dedication to the principles of Judaism; his support of seminary programs and for leadership in enriching the spiritual life of his community. Jean is Vice President of Congregation Beth Israel, Worcester, chairman of the Friends of the Jewish Theological Seminary of America. . . . From **James Gilman** the short note that he is now Director of Quality Control and Industrial Engineering, Bay State Abrasives Division of Dresser Industries and Vice Chairman and Commissioner of Massachusetts State Building Code Commission. Jim and his wife Evelyn live in Framingham, Mass. They have one daughter who teaches and a son who is a social worker. They have two grandchildren.

Jeanne P. Henry is Chairman of the Department of Business Economics and Finance at Federal City College, School of Business & Public Management, Washington, D.C. . . . **J. Halcombe Laning** advises that since 1945 he has been a mathematician/computer scientist with M.I.T. Instrumentation Lab (now C. S. Draper Lab.). At present he is head of the digital computation department and is involved in transportation, industrial automation and other new fields as well as more conventional (e.g. Apollo) guidance and navigation systems. Do not forget our reunion on the Cape in June. New class officers are to be elected. If you have any suggestions, write to **John Danforth** or your secretary. After 25 years, in the words of General Sherman, if nominated I will not run, if elected I will not serve. **Frank Yett** has indicated he would be willing to serve as secretary but of course other nominations are welcome. — **Al Guttag,** Secretary, Cushman, Darby and Cushman, 1801 K Street, N.W., Washington, D.C. 20006

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For the third month in a row we have '41 class notes in before the deadline. There's always good-news; bad-news. . . . We heard from **Ivor Collins** who is with G.E. Ordnance Systems in Pittsfield, Mass. working on Poseidon missile guidance systems. His three week vacation tour of Spain, Portugal, and Morocco sounded tremendous; Ivor also reports that **Bill Fox** is ill with pancreatitus and is improving. Bill's address is 1934 Edgewood Drive, Baltimore, Md. 21234. Cards or letters would really be welcome. . . . You start feeling old when you hear that class members are retiring, even though they received their doctor's degree with your class. **Carl Oldach** retired after 33 years with Du Pont as Vice President and General Manager of the Organic Chemicals Department. It is a coincidence that a good friend of mine moved into his job.

We also received a notice from Pricilla Bone that our classmate **John E. Bone** died. He was Vice President of American Export Lines and Director of the nuclear ship Savannah, and ex-Vice President of F.A.S.T. (First Atomic Ship Transport). We offer our condolences to Mrs. Bone and family.

I find within my own company, United States Steel, that **Bill Fader** has been made Vice-President of Operations - Eastern Steel Division. He was a Sloan School masters degree graduate in our year. . . . I talked recently with **Larry Turnock** who is with Republic Steel in Cleveland. He's about through educating his four girls and like many of us doesn't know how we did it! . . . **Ken Tsunoda** who is President of Extremultus in Englewood, N.J. calls me on occasion . . . I'll let him explain what "Extremultus" does.

I'm writing this in December but it will not be published until February so I hope you all had a joyous holiday season . . . in any case — Happy New Year. — **Henry Avery,** Secretary, U.S.S. Chemicals, 2863-600 Cerant St., Pittsburgh, Penn. 15230

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Last October two of our fine classmates received recognition for their accomplishments. **Oivind Lorentzen** was presented a "For New York" award by the City Club of New York, which honored twelve persons who are foreign-born for their contributions toward making New York a "world city." He is president of Flagship Cruises, a fact we will keep in mind as a 35th Reunion scheme. . . . **Stan Proctor,** whom we mentioned last year as a Trustee of Hiram College, Ohio, was inducted into that college's Garfield Society, formed to recognize those individuals whose careers and public lives have been outstanding. . . . **James P. Craft** wrote that he chaired a panel on laws of the sea at the Northeastern Political Science Association last November, and that he was elected to the editorial board of *Polity,* the association's journal.

John P. Longwell, senior scientific advisor in the Corporate Research Laboratories of Exxon Research and Engineering Company, has been named a visiting professor at M.I.T. for the coming academic year. You will recall our mention of his receiving the Combustion Institute's award last year. . . . Your secretary talked with **Howie Mattes** and **Jim Hoey,** who were braving a winter weekend at Jim's estate in Chatham on Cape Cod. Both seem full of vinegar and zest, and were planning some interesting boating activities for next Spring, such as navigating outside of Pleasant Bay. It is 80° in Santa Barbara today, typical Christmas shopping weather. Write me of your impending retirements, etc. — **Richard M. Feingold,** Esq., Secretary, 3757 State St., Santa Barbara, Calif. 93105

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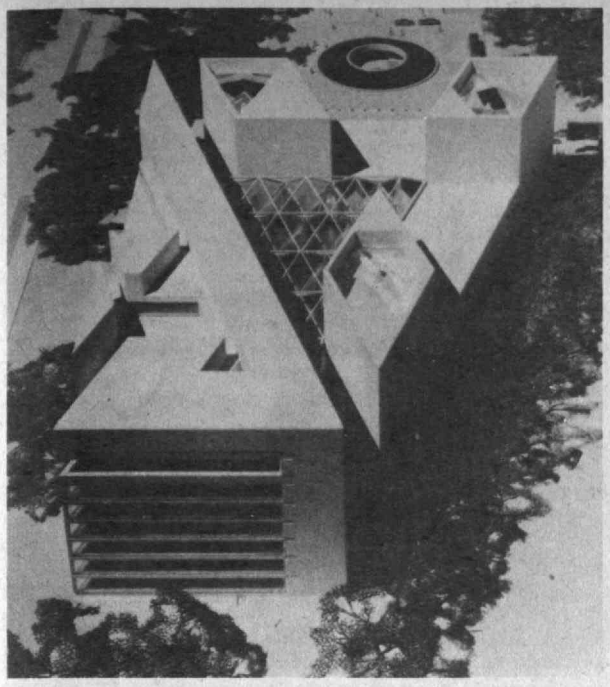
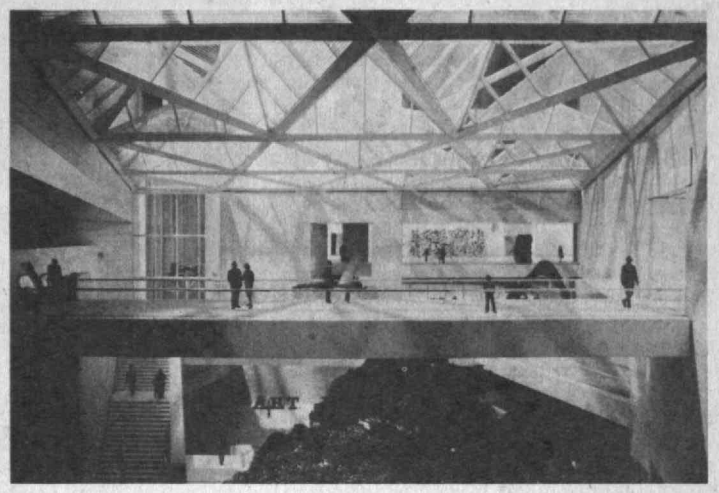
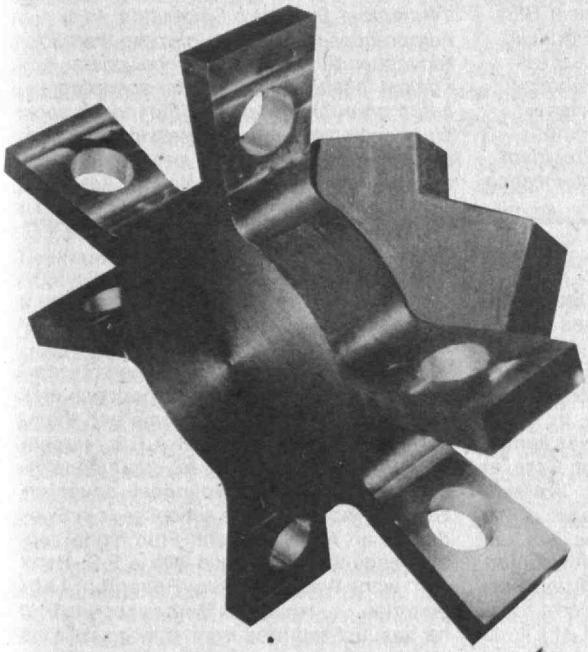
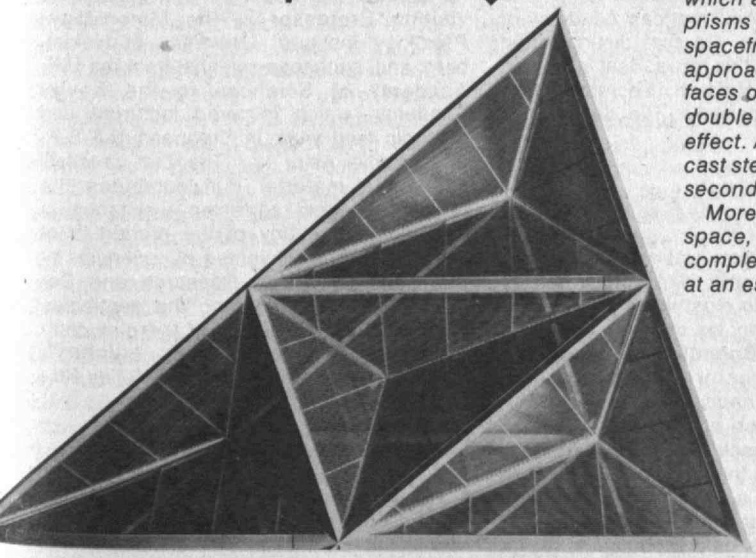
Should there be a doubt in anyone's mind the year 1975 represents our 30th Reunion, not 35th as reported in the December issue. By now you should have received your Reunion Committee's first mailer advising









The problem was twofold: first, the architect had to tie a trapezoidal-shaped plot into Pierre L'Enfant's city plan of formal radial symmetry for Washington D. C. – bringing contemporary design into the midst of traditional neo-classic marble monuments; and second, he was to create a gallery space equipped to house today's art in a new addition to the National Gallery of Art.

Ieoh Ming Pei, '40, solved the problem by forming two complimentary triangles which divide L'Enfant's trapezoid diagonally. A unique roof structure on the two triangular buildings is supported by 31 massive steel castings, 12,000 lbs. each. The smaller building contains a six-story library surrounded by a study center; the larger, three museums (photo at top left).

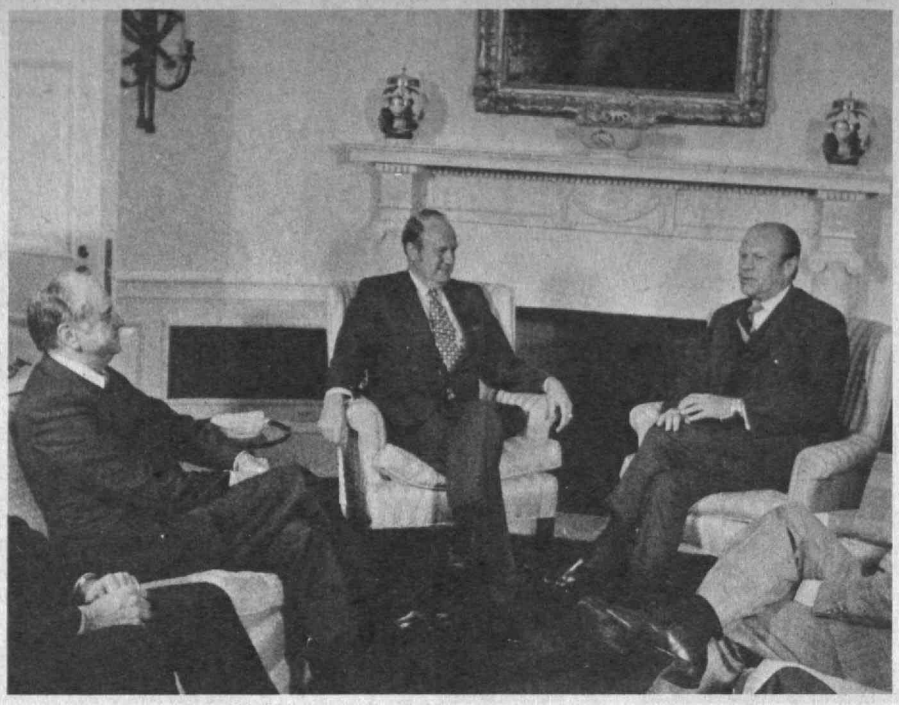
A spacious triangular court roofed by an enormous skylight (large enough for huge sculptures) joins the two buildings (photo directly above). Architecturally termed a "triangular offset grid spaceframe," the skylight will be essentially comprised of a series of 11-ft.-high modular tetrahedrons, which appear as triangular glassed-in prisms (photo at bottom left). (There are no spaceframes in existence which even approach this in scale.) Glazing inclined faces of the modules with 1⅝" thick double glass will produce the "skylight" effect. A key component of this structure is cast steel nodes, which accept primary and secondary supports (photo at center left).

More than doubling the museum's exhibit space, the two buildings' expected completion is for the bicentennial in 1976 – at an estimated cost of $50 million.

one and all of our gala plans. We look forward to seeing you all at Chatham Bars Inn on the Cape or on the M.I.T. Campus.

Thursday, December 5 was a most exciting day for your secretary as it gave him the opportunity to see one **David R. Clare** for the first time in 20 years! Dave was in Cambridge for the annual meeting of the Corporation Development Committee along with **Sherry Ing, Paddy Wade,** and yours truly. Dave is the youngest looking 50 year old that we've seen in years which must mean that his 20 hour days with Johnson & Johnson have not bothered him a bit. Oh yes, wife Peggy has helped as well. Sherry Ing together with his wife Julie were on from Honolulu visiting student daughters at Yale and Simmons amongst other items. We continue to be awed by **Emily V. Wade**'s varied interests, especially her active role in turning around the activities of the Zoological Society and Franklin Park in Boston!

Bob Roth is serving as membership chairman of the M.I.T. Alumni Center of New York. . . . **Peter Agoston** recently received his private pilot's license and has been spending his late summer and fall weekends exploring our wonderful New England Coast. . . . Frannie and I had a wonderful Saturday in late November becoming reacquainted with Pete and **Lou (T. R.) Hickey,** now of Topsfield — do they ever enjoy being back home. . . . Although we have not seen her ourselves, we are told that **Chick Street**'s new 2-ton aluminum hull racer is a masterpiece. Grandmother, named after Helen Marie so we are told(!), was built by Paul Luke in East Boothbay this past summer and should be ready for a hot racing season come May 1975. Now what do you suppose Chick will be doing this year? The news barrell is empty! How about some help? — **Clinton H. Springer,** P. O. Box 288, New Castle, N.H. 03854



Double-digit inflation is a new, puzzling, even frightening experience to most U.S. citizens — the more frightening because the experts find it more inevitable than manageable. United States Chamber of Commerce Board Chairman Charles H. Smith, Jr., '42, (center) and Chamber President Arch Booth met with President Ford in September to present anti-inflation policies prepared by the Chamber's 14-member Executive Committee. In a comprehensive package of more than 30 recommendations for a national policy against inflation: a $10-billion spending cut, a gradual reduction in the money supply growth rate, and Congressional efforts to carry out the letter and intention of the recently enacted Budget Reform Act.

49

My trips to and from Boston and Rio de Janeiro have unfortunately been out of phase with the class notes publishing schedule this year, and I apologize for the somewhat erratic and fragmented results. My records and I seem always to be at opposite ends of the trajectory!

Pre-Christmas weather in the Boston area comes as a welcome relief from the "summer" heat and humidity of Rio, but Sonya and I probably find it easier to take because we know we face only a limited dose of winter. By the time this issue arrives, we'll be resaturated with summer and awaiting Carnival. Not altogether a disagreeable prospect. This month, no alumni fund envelopes to report, so I can deal with other news items and releases. First off, **Len Newton,** fresh from his success with our 20th Reunion fund drive, ran as an Independent candidate for the U.S. Congress from the 5th congressional district of New Jersey, against three others. His kick-off literature and election strategy looked good to me, but his bid for elected office was unsuccessful. So far, I have no other details. Perhaps Len can enlighten us at a later date. . . . **Peter K. Stein** will arrange yet another short course in "Measurement Systems Engineering" in Phoenix, March 17-22, 1975. This is really a long-run program, spanning 13 years, and 100 previous performances!

William C. Schneider is now Deputy Associate Administrator for Manned Space Flight for N.A.S.A. . . . **Thomas C. Duke** has been named Manager of Management Information Systems at General Motors' German subsidiary, Adam Opel AG, in Ruesselsheim. . . . **Edward Dinowitz** was named Manager of Engineering at Instron Corp. in Canton, Mass. . . . **Ross O. Watson** became Assistant General Manager of the Organics Department of Hercules, Inc., up from General Manager of the New Enterprise Department, last April. . . . **Allan Perlis,** professor of computer science at Yale, and S.M., '49 in mathematics at M.I.T., is now a Fellow of the American Academy of Arts and Sciences. On that distinguished note, we close for this issue. Best wishes to all. — **Frank T. Hulswit,** Secretary, Rua Redentor, 309, Ipanema, Rio de Janeiro, G.B., Brazil

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Herbert Bennington was elected to the Montgomery County, Maryland School Board and had the most votes of the eight candidates running for the four positions. . . . **Joseph T. Benedict** has been appointed director of the Pharmaceutical/Chemical Masters of Business Administration at Fairleigh Dickinson University, Teaneck, N.J. . . . **Joe Oppenheim** reports that he is now living in Satellite Beach, Fla. He returned to Florida on Labor Day after a trip to St. Louis, Mo., where the Baha's held their first national conference. This fall he plans to take a course at the Florida Institute of Technology.

Fred Werner tells us that he and his family enjoyed a marvelous experience this past year — sharing their home and themselves with Ana Maria, an A.F.S. student from Peru. Now Fred has four daughters instead of three. His youngest daughter, Susan, is spending this school year in Sweden as an A.F.S. student. Fred highly recommends the experience with A.F.S. He is still with Westinghouse Research Laboratories. . . . **Hubert L. Barnes** reports that he has just returned from eight months as visiting Professor in the Mineralogy-Petrology Institute, University of Heidelberg; and, exchange scientist from the U.S. Academy of Sciences to the Soviet Academy, which involved lecturing and geologic field work in European U.S.S.R. and Middle Asia. . . . The first practical composite material that combines the temperature and corrosion resistance of ceramics with many of the properties of metals has been invented by scientists a the General Electric Research and Development Center. Among the gentlemen describing the properties of the new composite was **Richard L. Mehan. — John T. McKenna,** Secretary, 2 Francis Kelley Rd., Bedford, Mass.

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It's not often that a member of the class makes the front page of the major news-

papers from coast-to-coast. **Burton Richter,** Professor at Stanford University, and leader of a team at the Stanford Linear Accelerator (S.L.A.C.) has cooperated with a group at Brookhaven National Labs in the discovery of a new particle variously described as the Neutral Vector Boson of the "J" particle or the "Psi" particle. This particle was discovered at S.L.A.C. by a group of Stanford physicists while experimenting with colliding beams of electrons and positrons. At Brookhaven, physicists from the Massachusetts Institute of Technology and from Brookhaven National Laboratories found the particle in an experiment bombarding a proton target with protons. The discovery, which stemmed from research sponsored by the U. S. Atomic Energy Commission, was announced simultaneously Saturday, November 16, 1974 by the physicists involved.

Among the various notes which have come in are the following: **William P. Chandler** writes that he has been the Youngstown Division Sales Manager of Pure Oil Company since March, 1973. His operation covers ten counties in Ohio and generates $80 million in annual sales through 340 service stations. Bill's daughter, Lisa, 20, is a Junior at Syracuse studying nursing. His son, Jim, 17, is a senior in high school. Bill apparently doen't believe that oil is going to be available forever — his hobby is horses, and he owns six America saddlebreds. . . . **Omar Wing** is now Chairman of the Department of Electrical Engineering and Computer Science at Columbia University. He has joined the ranks of our classmates who have children at M.I.T. His daughter, Jeannette M. Wing, is a Freshman at M.I.T. this fall. . . . **John J. Dieckmann** was recently appointed Director of Engineering, Harrisonburg Division, Dunham-Bush, Inc., Harrisonburg, Va. . . . The Manager of Consumer Equipment Engineering at Bowmar/Ali is **James H. Bunting.** Jim continues to be responsible for the design of Bowmar pocket calculators in addition to the design of new Bowmar/Ali consumer products. Jim was awarded the Wood badge by the Boy Scouts of America. His daughter, Mary, has been elected to Phi Beta Kappa at the University of Massachusetts.

From the world of architecture **William D. Warner** reports that the Pierce School in Brookline, Mass., which was designed by his firm, is now being displayed in an exhibit of New England Architecture at the DeCordova Museum in Lincoln, Mass. Bill has recently been appointed to the National A.I.A. Committee on Design. . . . **John Robert Henderson** is working as an architect and urban designer doing major work in master planning and consulting for colleges and universities. John has just completed the master plan work for Santa Barbara Community College District. He is also consultant to the University of Calif., Santa Barbara and the County of Santa Barbara Park Department.

We are all aware of the energy problem. **Leith Holloway** is tackling it by driving his car less and less and walking and bicycling more and more. He urges us all to do the same. According to Leith, "even if it doesn't reduce our dependence on foreign oil by much, it certainly is healthier and makes one feel better." . . . Also working on the energy problem are **James Margolis,** who has presented a paper on "Petrochemical Feedstock and Fuel Shortages" to the American Chemical Society National Meeting in September in Atlantic City; and **Charles Marion** of the Texaco Development Corporation, who present papers on "Recent Experimental Results on Gasification and Combustion of Low B.T.U. Gas for Gas Turbines" at the International Gas Turbine Conference in Zurich in April 1974 and on "Partial Combustion of High-Sulfur Fuels for Electric-Power Generation" at a meeting of the Electric Power Institute (EPRI) in Monterey, Calif., also in April 1974. . . . **David W. Ulrich** left Exxon two years ago after 20 years service. He has since done some consulting and teaching, and will join Newfoundland Refining Company, Ltd., on January 2, 1975 as Assistant Refinery Coordinator. David will be located at the main office of the company in New York City. He and his wife, Barbara, just bought a house in West Hartford, but now will move to Southern Connecticut.

A note from **Edwin H. Porter, Jr.** indicates that he is Special Assistant to the Chairman of the Board of Draper Laboratories at M.I.T. and is responsible for Draper's new building project. . . . **John F. Maxwell** reports that he is Director of Technical Assistance Center (T.A.C.) at the State University of New York, Plattsburgh. T.A.C. is quasi-consulting in the field of regional economic development. John was also recently appointed Adjunct Professor of General and Continuing Education in Management at the University. . . . The Director of Princeton University's Program in Geophysical Fluid Dynamics is **George L. Mellor.** The program is a result of an arrangement between Princeton University and N.O.A.A.'s Geophysical Fluid Dynamic's Laboratory and offers a unique opportunity to graduate students interested in Dynamical Meterology and Physical Oceanography. . . . **Richard E. Lyle** writes that he and his 15 year old son had a ball bumming their way through Greece, Turkey and Egypt in May and June 1974. He took photos of Sadat and Nixon in Cairo. Dick was selected for the U. S. Army War College Nonresident Class of 1974-1976 so he has started on an exciting two years of strategic studies. . . . The Detroit Institute of Technology has announced that **Edward C. Levy, Jr.** of Birmingham, Michigan has been elected to the Board of Trustees of the Institute. The announcement was made by Dr. Dewey F. Barich, President of the 83-year old institution. Mr. Levy is president and chief executive officer of Edward C. Levy Company of Detroit, one of the leading material handling systems and material supply companies in the area employing more than 1,000 people. . . . The Board of Managers of the American Bureau of Shipping has appointed **William M. Hannan** to the position of assistant vice president. Mr. Hannon has been associated with the American Bureau of Shipping for 22 years as surveyor on the Hull Technical Staff in New York City and London. His most recent position was that of principal surveyor and chief surveyor of the Hull Technical Staff. Before joining the American Bureau of Shipping, Mr. Hannan received his Master's License and served in various deck officer capacities in the fleets of National Bulk Carriers, Inc., and Socony Vacuum Oil Company. . . . **Fujio Matsuda** of the University of Hawaii, Honolulu, Hawaii has been elected to the National Academy of Engineering for his leadership in the development and operation of a state-wise transportation system.

Our class will be saddened to learn of the death of **Bernard D. Ross** of 24451 Lake Shore Boulevard, Cleveland, Ohio. Mr. Ross was President of Collateral Services, Inc., of Cleveland. . . . Also the death of **Larry Strickland,** Manager of the G.S.I. Croydon-Amstelveen processing complex of Texas Instruments. He was 48 years old. He received a Ph.D. in Geophysics from M.I.T. and in 1955 started work with G.S.I. in Houston, Texas. During the next several years, Larry was a member of the technical staff of the Texas Instruments Central Research Laboratory and later the Science Services Division. In 1963, he began a series of assignments in Geosciences Operations serving as manager of Earth Science programs and later as manager of Earth and Marine Science programs before being promoted to manager of Geosciences in 1966. He was manager of New Services Business Development from 1969 until November 1972, when he was appointed to the Croydon post. Larry's professional activities and contributions were in many fields including mass spectrometry and geologic age determination, gravity, surface sources, nuclear test detection and earthquake seismology, submarine detection and underwater acoustics, oceanography, health services, geophysical exploration, and management. Larry is survived by his wife, Shirley; daughters Sharon, Holly and Dennise, and a grandson. His funeral services were November 8 at St. Barnabas Church, Purley, Surrey, England followed by burial in Dallas, Texas. — **Arthur S. Turner,** Secretary, 175 Lowell Street, Carlisle, Mass. 01741; **Richard F. Lacey,** Assistant Secretary, 2340 Cowper St., Palo Alto, Calif., 94301

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Dear '53ers: A helluva Christmas present I got from you folks — three brief notes forwarded from the M.I.T. Alumni Association. Like they say, "There ain't no news from home, boss." So it's going to be "a long winter's night," for *both* of us.

Mark Schupack writes: "Having given up the chairmanship of the Brown University Economics Department after five years, I am on leave this year as a Visiting Scholar at M.I.T. Hope to do some writing and learning this year." Mark, the latter *is* long overdue. . . . **David Klepper** noted that he is ". . . busy in architectural acoustics consulting with such architectural firms as Perkins & Will, Edward Larrabee Barnes, Ulrich Franzen, Edward Durrell Stone, Minora Yamasaki and Schweizer Associates." . . . **John Batter,** his wife and four children have recently moved from Lincoln, Mass. to Rochester, N.Y.; he just joined Xerox Corp.

And that *is* all the news, dear friends. So please have your wives *or* husbands, mistresses *or* gigolos, *or* what-have-you's, to send me some fresh material. — **Martin Wohl,** Secretary, 7520 Carriage Lane, Pittsburgh, Penn. 15221

54

Dave Sternlight is back in Los Angeles as

manager of political economics for Atlantic Richfield, after a years assignment as a Presidential Interchange executive. Dave served as Deputy Director of Policy Development in the office of Peter Peterson, the Secretary of Commerce. . . . If you enter Philadelphia by Metroliner, drop in to see **Charlie Smith,** whose office is conveniently located at Rm. 233, 30th Street Station. Charlie reports that the Penn Central continues to run by from force of habit and that he and wife Pat continue to enjoy life in Strafford-Wayne (suburban Philadelphia). . . . Carole and **John (Pete) Peterson** were in Boston last summer with their daughters Melissa (15) and Jennifer (12) for a New England sightseeing vacation. Pete has been with B.F. Goodrich for nine years, most recently with the International Division. While here Judith and **Dean Jacoby** gave them a guided tour of historic Concord, Mass.

Bill McTigue is taking on an exciting new responsibility. He is opening the New England office of Dames and Moore, a large New York based consulting firm, in Lexington, Mass. Those of you having wet basements can contact Bill at No. 4 Militia Drive in Lexington. . . . Note from your class officers. As we mentioned last month, a directory is being published which will list all class members, with addresses, and, if enough of you respond, phone numbers too. Please send recent changes and phone numbers so that they can be incorporated in the directory which will be published and distributed in the Spring. — **Lou Mahoney,** 14 Danby Rd., Stoneham, Mass.; **Chuck Masison,** 76 Spellman Rd., Westwood, Mass. 02090; **Dave Howes,** Box 66, Carlisle, Mass. 01741

55

There has been a recession in class notes from those of you who should be sending in announcements of current events to your class secretary. However, you are all forgiven this month because **Mike Hornstein** came through. His letter follows: "Dear Al: I thought it might be a good time to break my self-imposed silence, insofar as the class notes are concerned. I have been with Hughes Aircraft Co. since receiving my Sc.D. degree in 1960. Presently, I am Manager of the Communications Analysis Dept. in the Space and Communications Group. My work the last few years has been concerned largely with the application of Hughes communications satellites to foreign domestic systems. Marketing activities on these programs have taken me to Brazil, Iran, and Indonesia. It is no coincidence that the latter two are among the oil-rich nations.

"My marriage five years ago was duly reported in the class notes. Charlotte and I now have a son, Scott, who will be a year old on December 13. We live in the Brentwood area of Los Angeles, in a house we bought last year. It is difficult to maintain a sanguine attitude when our economy, if not our society, seems to be crumbling, but at least from a personal point of view things are quite good. I hope this letter finds you well and happy." And I hope that Mike, his family, and all of us have a good and happy 1975. — **Allan C. Schell,** Secretary, 19 Wedgemere Ave., Winshester, Mass. 01890

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Walter Baturka is president and general manager of Universal Engineering, Frankenmuth, Mich. Universal is a division of Houdaille Industries. . . . **Jewell R. Bowen** is Associate Vice Chancellor of the University of Wisconsin. . . . **Warren Briggs** now teaches at Bentley College in Waltham, Mass., and is the head of the computer systems curriculum. Last summer, he was a member of the visiting faculty for the Sloan program. . . . The **Coleman** family sent greetings via their annual Christmas letter. John continues to work on the Boeing hydrofoil while the family enjoys the sensational outdoor life around Seattle. . . . Not long ago the New England Business Journal carried a full page article on Zircon Company, whose president is **Curt Flory.** Zircon is a relatively new management consulting firm, which, among other services, offers specialty programs for small desktop computers. . . . **Charles Green** writes that he is semi-retired in Florida but manages a commodity trading firm. . . . **Dick Jacobs** now is in charge of A.T. Kearney's management systems and financial practice at the consulting firm's Chicago headquarters.

Richard Miller is area manager for Measures Systems, a California based supplier of computer process control systems. . . . **Max Plager** writes they are moving from Chicago to Highland Park. On the teaching side, his department now offers a degree in computer sciences and graduate actuarial courses. . . . Astronaut **Rusty Schweickart,** lunar module pilot for the March 1969 Apollo 9 flight, was recently named to the staff of the N.A.S.A. Office of Applications as Director of User Affairs in Washington, D.C. Rusty also served as backup commander for the first Skylab mission. — **Bruce B. Bredehoft,** Cosecretary, 2 Knollwood Drive, Dover, Mass. 02030; Mrs. Lloyd Gilson, Cosecretary, 35 Partridge Road, Lexington, Mass. 02173

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John A. Currie asked that a note appear in the February *Review* of the passing of **James Chorak** in Rio de Janeiro on November 28, 1974. He writes: "His funeral was held in Pueblo, Colo. where **Vern Porter,** represented not only himself, but those friends and classmates who could not attend. Since his graduation, Jim served in the Air Force and then joined Hughes International. He worked in California, Belgium and most recently in Brazil where he was President of Hughes of Brazil, a subsidiary he started and was developing for the company."

Those classmates and friends who want news of Gwen and the children, should feel free to contact Mr. Currie at Room 4-106, M.I.T. — M.L.

59

A thin column of news this month. — **Robert Broder,** now in Mexico, is Director of Latin American projects for Brown, Daltas & Assoc., a firm of architects and planners. . . . Still in the field of architecture, **Ernest Kirwan** was recently made a partner of Keyes Associates, a 140 person staff of architects, engineers, and planners with four offices throughout New England. In addition, to his professional activities, he is active in alumni affairs as Vice President of the Rhode Island School of Design Alumni Association. . . . Moving towards the West Coast, **Richard Talbot,** now a Major in the Air Force following graduate work at the Air Force Institute of Technology, is on detached duty with Rockwell International in Los Angeles as part of the management link between the Air Force and Rockwell in the development of the new B-1 strategic bomber.

Further notes were sent from **Bob Muh:** "Greetings to everyone from your Assistant Secretary in Los Angeles. I'm sorry I missed seeing some of you at our last reunion but my wife was busy having our second daughter, Carrie. Having lived in Los Angeles for over two years now we have really learned to love it and I don't know if we will ever make the move back East. The number of members of the Class of '59 living in the Southern California area is increasing each year and I hope to personally contact many of you in the months ahead.

"**Mike Intriligator** has been living here since 1963. Mike is a full Professor of Economics at U.C.L.A. Mike's wife, Devrie, also an M.I.T. grad ('62) is a Professor of Physics at the University of Southern California. They have four children, all boys, ages two to nine. . . . A short note from **Marty Zimmerman** indicates that Marty is well and is living in Chicago. Marty is Vice Chairman of Telco Marketing Services, Inc. The Company is a leasing specialist in the health care field. . . . I also saw **Vic Mashaal** earlier last year during a business trip to New York. Vic is living in Montreal and is in the real estate and construction business.

"I trust 1975 will be a good year for all of you. Please write to your regional secretary and let us know what you are doing."

When you have a chance, please drop a short note to **Phil Richardson,** 180 Riverside Drive, New York, N.Y. 10024; **John Amrein,** 770 Greenwood Avenue, Glencoe, Ill. 60022; **Bob Muh,** 907 Chantilly Road, Los Angeles, Calif. 90024; **Adul Pinsuvana,** 49 Seri Road, Seri Village, Hua Mark, Bangkok, Thailand; or myself. — **Allan Bufferd,** Secretary, 8 Whitney Road, Newtonville, Mass. 02160

61

Only a couple of notes this month. Come on you guys — write me, I'm lonely. **Tom Hastings** did write and he says that he is still over at Digital Equipment in Maynard, Mass. designing PDP-10 hardware and software. He still has time to go sailing occasionally. Last summer he was out on the water of Martha's Vineyard with **Ed Sonn** and Lita and **Don Nelsen.** . . . **Irwin Sobel** is also in the computer game. Irwin spent a couple of years teaching computer science at the Technion in Haifa, Israel up 'til August '73. Since then he has been doing research into the uses of computer vision in biological sciences at Columbia University. He may occasionally meet **Donald Graham Morrison** who teaches in the Columbia Graduate School of Business. Don says that he took off nine months for a sabbatical to see how theory works in practice in industry. Since Don's wife also teaches at Columbia, at the Medical School, it looks like the Grahams

and their two girls (eight and five) will be in New York for some time.

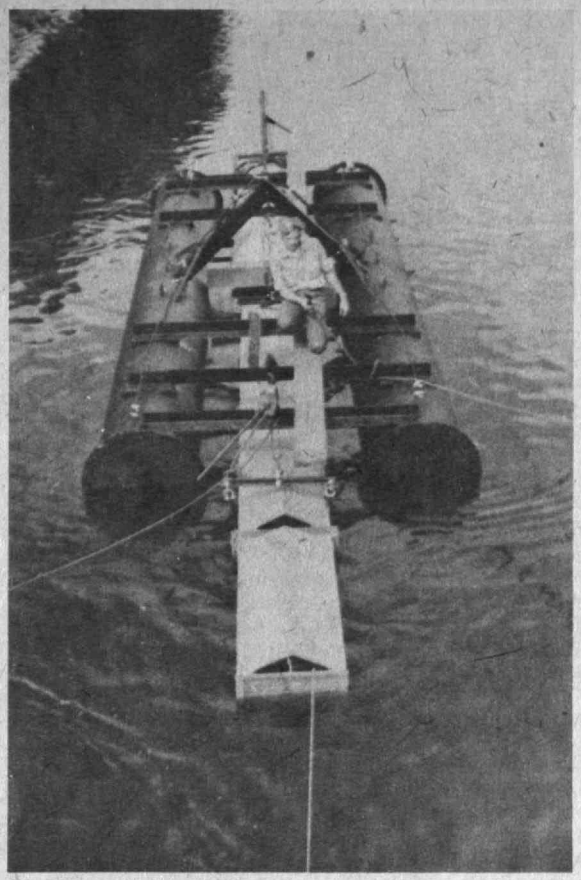
Lloyd Fisher is also active on the academic front. He writes: "I am a full professor of biostatistics at the University of Washington as of last July. I am co-director of the Coordinating Center for a national collaborative study of coronary by-pass surgery sponsored by the National Heart and Lung Institute. . . . **Dwight Kennard** — who is a success of the M.I.T. R.O.T.C. program has recently moved from Hickam A.B. in Hawaii to Elgin A.F.B. in Florida where he teaches navagation to flegling aviators.

Finally a note, issued under duress, from **Bill Hecht.** Bill called me the other night to get me to contribute some money the M.I.T. sailing pavilion. He gave me a sad story about how the boats were all moldy. I gave and so did he. To wit: "I've been back at M.I.T. since 1967. I'm now Director of the Educational Council, the alumni-undergraduate student contract arm of M.I.T. About 1,050 alumni and alumnae, including many Class of '61 people, are Educational Council members. I'm also the Associate Director of Admissions. My wife, Olive, and three children and occasionally I, live when not at the 'Tute in Reading, Mass". Thanks Bill. I need more goodies to fill this column up. Do your part and write. — **Andrew Braun,** Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

62

John E. LaGraff was recently promoted to Associate Professor of Mechanical and Aerospace Engineering at Syracuse University. He is currently Chairman, Central New York Section, American Institute of Aeronautics and Astronautics. . . . **Eugene Finkin** has changed companies and is now Director of Research & Development for Burgess-Norton Mfg. Co., a division of AMSTED Industries located in Geneva, Ill., 40 miles west of Chicago. He and his wife, Lillian, are expecting their second child, due in April. . . . **Steven J. Brams** and his wife, Eva, gave birth to their second child, Michael Jason, on Sept. 26, 1974. His book, *Game Theory and Politics,* will be published by the Free Press Division of Macmillan in March, 1975; it will appear as a paperback. . . . **Charles C. Gerheim** has completed a two year contract in refinery technical management in Algeria, and returned to the Shell Oil head office in Houston. His rest and recreation consisted of a two and one half month, nine country swing through Europe, capped by return on the S.S. France. He is now trying to adjust to the more mundane existence in Houston. . . . **Edward A. Feustel** is still at Rice University in electrical engineering. He enjoys playing Go and HAM Radio. Wants to hear from residents of East Campus and Senior House.

Leslie M. Evenchick, after having worked for such companies as Xerox, TRW, UNIVAC, and Bonner & More, is now setting up his own business selling silver coins and bullion for investment purposes. He informs us that he is still an anarchist of sorts. . . . **Hal Metcalf** has been promoted to associate professor, physics dept., Stony Brook, as of September, 1974, and received a New York State Chancellors Award for excellence in teaching for the academic year 73-74. Also, his third child was born on



The treatment plant, on pontoons, was floated into place in Storrow Lagoon.

A Clean Charles?

Storrow Lagoon winds along the picturesque Esplande, a scenic enhancement of the basin shore — except for its thick, turbid water clogged with excessive growths of algae (up to 787,000 organisms/ml. in late summer, compared with 71,000/ml. in the Charles River.) For two years an experimental purifier has been hidden under a Storrow Lagoon pedestrian bridge, the beginning of a project that will — possibly — result in a full-scale water treatment plant cleaning the entire Charles River above the Lower Basin.

William Jobin, '59, directs the Storrow Lagoon pilot project (actually a small section of a full-scale plant) at Process Research, Inc., in Cambridge, under contract from the Metropolitan District Commission.

The unusual pollutants — salt water as well as industrial and human wastes — and fluctuating quality of Charles River water, and the fact that its treatment must be accomplished by a submerged facility, made a great deal of experimentation necessary. New settling tubes and a sludge removal system were designed to minimize the size of a treatment plant to resolve turbidity and color. Assembled in Cambridge and floated into place on a barge, the pilot plant was anchored in the west inlet channel of Storrow Lagoon on piles in June, 1973. Operations began in July and continued until November. The system is simple: river water, pumped into the submerged treatment plant, is circulated with coagulant chemicals (alum and polymer), which cause suspended pollutants to come together in larger, heavier particles (floc). Cleaned water from the plant is pumped into the closed lagoon, and the floc particles are pumped into sludge tanks.

At first, it was only for a few days in August, 1973, that the effluent of the treatment plant was sufficiently clear to meet the Massachusetts standards for swimming. But by the month of September, plant performance improved considerably as operational problems were overcome. During that month, "the removal of color and turbidity averaged 71 per cent and 63 per cent respectively . . . during many runs the removal rates went above 90 per cent," Process Research, Inc., reported to its M.D.C. sponsors. Chlorination could then be used to reduce bacterial content to suitable levels, meeting the basic requirements for bathing areas. "The September operations gave clear evidence that the treatment plant could be used to produce water acceptable for swimming, using the Charles River as a source."

What would be the cost of a full-scale plant? Construction of a treatment plant to be located upstream in Waltham or Watertown is estimated at $2 million. At first it appeared that maintenance costs would be high — $850,000 a year (assuming plant operation was during the six months of the year when river treatment would be practical). But during 1974, the second year of experimentation, dramatic cost-reduction resulted from using different coagulation chemicals in lower doses. A projected annual operating cost between $200,000 and $250,000 is now thought to be economically feasible.

If a full-scale plant were constructed, five beaches could re-open along the Charles — and the lagoon, thinks Dr. Jobin, would in time also become suitable for swimming. □

America's Cup

I must go down to the seas again, to the lonely sea and the sky, And all I ask is a tall ship and a minicomputer to steer her by.
(with apologies to John Masefield)

Although the America's Cup 12-meter yacht race strictly regulates the general size and shape of the boats, much is left to the designer and crew. In the process of beating their Australian challenger *Southern Cross* last summer, the American designer and crew of the *Courageous* proved that the age of technology is upon us.

Halsey C. Herreshoff, S.M. '60, navigator for the races, termed the *Courageous* an "engineer's boat." (Herreshoff is the grandson of the pioneer yacht designer Nathanael Herreshoff, whose design innovations in the 1900s, among them the weighted keel, are still utilized today.)

Herreshoff pointed out that the *Courageous* was built of finely crafted aluminum, rather than the traditional wood, and it introduced such innovations as a telescoping, hydraulically-operated boom to adjust sails and new super-tough materials for sails and rigging. The crewmen even tape-recorded a pleasant-voiced woman counting down the time until the start of the race, presumably a more calming sound than a sweating sailor bawling out the minutes.

But Mr. Herreshoff's baby was clearly the minicomputer he used to plot the complex maneuvers of the 24-mile course. The computer automatically took data on wind direction, magnetic direction, heel angle, boat speed and the wind's angle of attack from conventional instruments. Mr. Herreshoff added other data, and the computer determined the best sail-settings and angle of attack for each leg of the course.

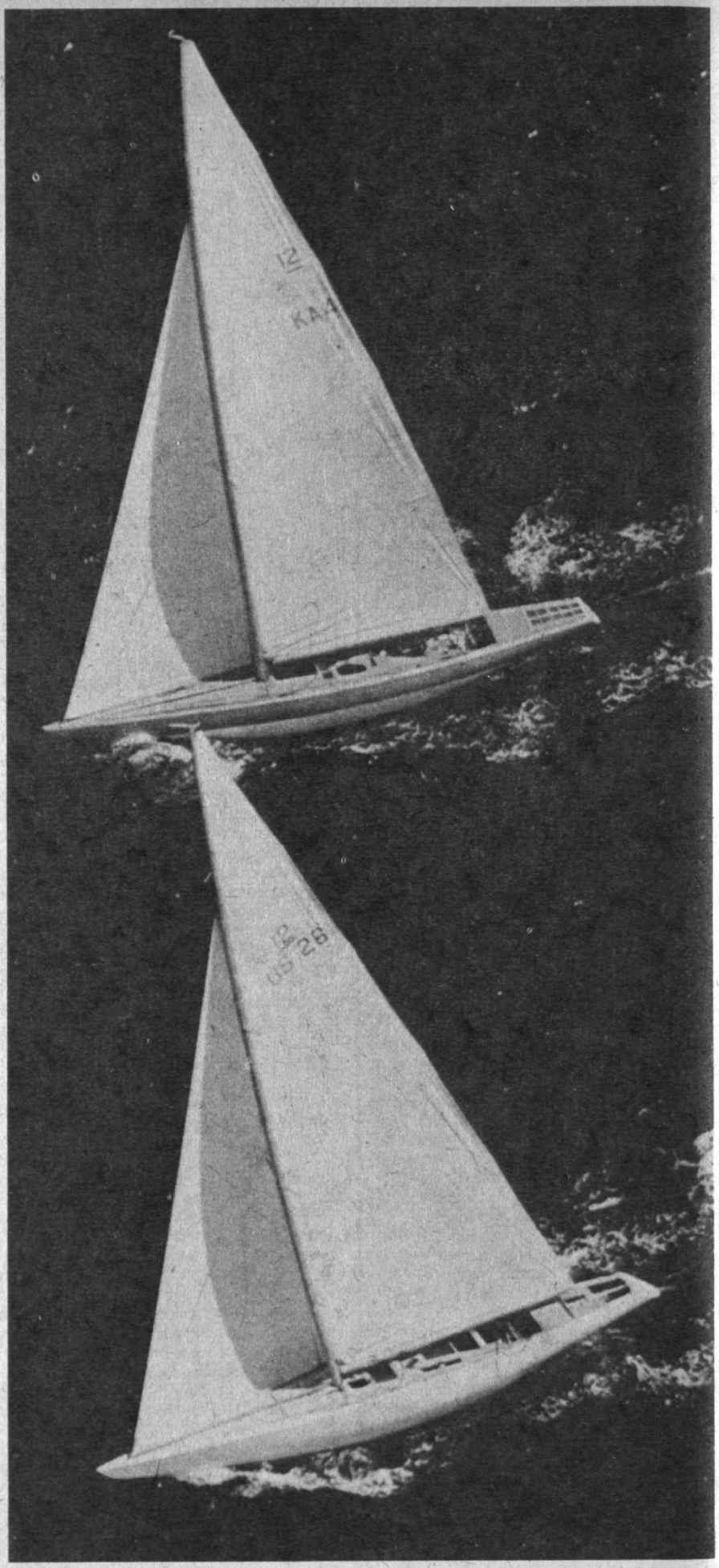
Mr. Herreshoff thinks the computer, in this case designed by engineer Rich McCurdy, "adds an interesting new dimension to yacht racing." In fact, he told the Boston Section of the American Society of Mechanical Engineers this fall, the computer did such a good job of giving the sailors their heading that it outran the instrumentation. To Mr. Herreshoff one important job for the next America's Cup will be to develop better instruments to give better data for the computer.

Improvements in the computer itself are also expected. The *Courageous'* computer was developed in 1971 and could be improved upon by new solid-state technology.

"Unless they're outlawed, such computers will probably become standard items in yacht racing," contends Mr. Herreshoff.

But despite the new technology, there is still a lot to be said for the traditional art of shipbuilding and racing and for the importance of what Herreshoff calls "the human equation."

In qualifying trials, *Courageous*, with all its innovation, barely scraped by the last America's Cup winner *Intrepid* — a wooden boat with traditional rigging and navigation. — *D.M.*



AMERICA'S CUP ACTION. The American defender Courageous *(bottom) races the Australian yacht* Southern Cross *off Newport last summer.* Courageous *(and the four previous America's cup winners) was designed by Olin Stephens II, '30, and navigated by Halsey C. Herreshoff, S.M. '60. Photo: U.P.I.*

November 21, 1973 — a son, Jonathan. . . . **Jeremy E. Alperin** is still in Cleveland in practice at Cleveland Metropolitan General Hospital as Chief of the EHT Service. . . . **Richard Garber** is raising pears and christmas trees on 46 acres of the Hood River Valley. To make ends meet, he also is executive director of the local Community Action Program and is into organic growing and social change. . . . **Steven A. Orszag** has been promoted by M.I.T. to Professor of Applied Mathematics in the Department of Mathematics beginning July 1, 1975. . . . **Oliver R. Smoot** has been elected to the position of vice president of CBEMA. Mr. Smoot joined CBEMA in 1969 and prior to that was with the Institute for Defense Analyses and the Lamda Corporation. He and his wife, Sandra, and their two children, Stephen (seven) and Sheryl (four) reside in Annandale, Va. — **Gerald L. Katell,** Secretary, 7 Silverbit Lane, Rolling Hills Estates, Calif. 90274

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Short column this month — just a few notes and news releases. . . . **Mark Epstein** recently switched jobs. He is now at Computer Sciences Corp. in Falls Church, Va., near Washington, D.C. Mark directs contract activities in several technical areas. The Epsteins (including wife Joyce and three year old son Paul) live in Kensington, Maryland. . . . Another note from the East Coast was from **Patricia (Selby)** Marzilli. Pat is in her fourth year in the Baltimore area, where she is now a research associate in biochemistry at Johns Hopkins University. Pat's husband, Luigi, is on the faculty of the chemistry department of Johns Hopkins. Pat and Luigi both got Ph.D.'s in the same kind of chemistry at the Australian National University in Canberra, Australia. The Marzilli's have two children, Alan Stewart, four, and Veronica Gina, two. In between children Pat did some postdoctoral work with her husband, and helped a 100 year old chemist write his autobiography and a book on sulfur chemistry.

Edward J. Dudewicz is Graduate Committee Chairman in the Department of Statistics at the Ohio State University, Columbus, Ohio. He writes that he has recently become a mathematical analyst in the computer center in addition to his primary associate professor appointment in statistics. . . . **Dale Miller** has started work in the Materials and Effects Research group at Lawrence Livermore Laboratory after finally completing the Ph.D. program in the E.E.C.S. Department at U.C. Berkeley. His dissertation concerned experimental studies on semiconductors by scanning electron microscopy and Auger and X-ray spectroscopy.

A news release informs us that **Jon Wachtel** has been promoted to associate professor of physics at Yeshiva University's Belfer Graduate School of Science. Jon received his Ph.D. from Yale in 1967 in the field of plasma physics, after working in the Department of Engineering and Applied Science. After serving for two years as a lieutenant in the U.S. Navy he joined the staff at Yeshiva's Belfer School. Jon and his wife Ellen are living in New Haven. . . . **A. Truman Schwartz** has been appointed Dean of the Faculty of Macalester College in Saint Paul, Minn. After getting his Ph.D. from M.I.T. in 1963, Truman went to Proctor and Gamble Company as a research chemist. He has been at Macalaster since 1966, most recently as associate professor of chemistry. One of his popular courses at Macalaster has been his history of chemistry offered under the engaging title, "Introductory Alchemy or Making Gold for Fun and Profit."

One final note. I have decided to round file my Old News File. The news has become so old that I would be embarrassed to use it even for filler. That file, however, contained notes from about seventy classmates who I haven't heard from again. I know you're still out there, and if you drop me a line I'll let the rest of the world know what you're doing these days. — **Mike Bertin,** Secretary, 18022 Gillman St., Irvine, Calif. 92664

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Dear Classmates: Just to give you an idea of what deadlines are like, I'm writing this February copy while on vacation in Florida in December. I'll tell you about the vacation trip next issue. In fact, it may be our only March news if some '64 class heroes don't surface in a hurry.

Richard Boyd, '63, gets the 1974 award for maximum communication on the back of an Alumni Fund envelope. He has been a lecturer at University of Michigan as well as University of California at Berkeley. After that he spent four years as an assistant professor at Harvard and he currently holds an associate professorship at Cornell. His work areas are mathematical logic, philosophy of science, and philosophy of psychology, which he supplements with two hobbies: photography and collecting 17th century English Oak Furniture.

James Suhrer Dorr was an active participant this past political season, helping his local Democrats as a precinct committeeman and newspaper ad designer. Currently he is a member of the City of Bloomington Traffic Commission and he recently became engaged to "the foxiest redhead in the central United States." They plan to be married next August. . . . **Douglas J. Hoylman** has been promoted to assistant actuary with the Crum and Forster Insurance Co. . . . **Mark Lappin** and his wife Joan are now living in Needham, Mass. with their two sons. Mark is presently practicing law with Kenway and Jenney, Boston. . . . **Ed Wolcott** and family are still in Denver where he works for Gotes. Ed is now the local M.I.T. Educational Representative and just returned from an enjoyable train trip with the local M.I.T. Club.

News that has come to our attention is the appointments of **Albert Teich** as the new Research Director of the Institute for Public Policy Alternatives, which is a university-wide research center located within the State University of New York. . . . Also, we have heard of the appointment of **Leonard Buckle** as Assistant Professor in the Department of Urban Studies and Planning at M.I.T. for this academic year.

Received a nice note from **Bill Roberts** on the back of his Alumni Fund envelope (thanks for both of us, Bill). He has tenure as an Associate Professor at the University of Virginia. Since last June, Bill, Linda and their boys (Will and David) have been enjoying his sabbatical leave from the University of Virginia by visiting Groningen, Holland; Paris, France; Stockholm, Sweden; *and* M.I.T. Bill indicated that research would be his first priority during this leave (please call us when you're at Tech, Bill). That's all for this month. We look forward to hearing from all of you. — **Steve Schlosser,** Secretary, 15 Apple Hill Rd., Peabody, Mass. 01960

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This column represents two months' accumulation of notes. Pretty sorry, huh? Why don't you all write and make my last column (or my successor's first one) a big one? . . . **Edwin Kampmann** writes that he is still in the Department of Urban/Environmental Management at California State College at Dominguez Hills in Southern Los Angeles County. . . . Karen and **Stephen Deutsch** had a second child, Jeffrey, born last August. Stephen has finished law school at Harvard, passed the Massachusetts Bar Exam, and is now law clerk to Justice Kaplan of the Massachusetts Supreme Court. . . . **Leo Rotenberg** has been working as a systems programmer for Searle Medidata, Inc. in Lexington, Mass. The company builds medical information systems. I had occasion to read Leo's Ph.D. thesis in computer security a few months back and its quite a job — all 350-odd pages of it. . . . **David Kettner** was promoted to Assistant Group Leader at M.I.T. Lincoln Laboratory in July, 1973. The Kettners were expecting their first child to arrive last July. . . . **Herbert Mower** is involved in the design and planning of the Radiotherapy and Medical Physics Departments for the new Lahey Clinic Medical Center in Burlington, Massachusetts. . . . **Gary Williams** has joined the faculty of the University of South Carolina as an assistant professor of geology. Gary is teaching and doing research in the University's new marine science program. . . . **Alan Leslie** recently formed a company called Health Management Systems, Inc., specializing in health care management consulting. Alan is president of the company which he says has not yet made the New York Stock Exchange. . . . A little closer to the Big Board, I suspect, is Enviroplan, the enviromental consulting company that **Howie Ellis** founded in 1972. Enviroplan now has twenty full-time employees and annual sales of $500,000. The company has been doing policy studies, environmental analyses, and air quality prediction and measurements for three state governments and about 25 industrial clients.

Jim Hester writes that he is now getting settled in Los Angeles. Jim says he has a fine job with the Kaiser Health Plan and a funky little house. . . . **Steve Loutrel** writes that he spent five weeks last summer exploring the South Coast of Newfoundland with wife and Lizzie and some of Steve's students. The trip included sailing to Newfoundland and back, and hiking, climbing and fishing while there. Steve was a corecipient in 1974 (with M.I.T. Professor Cook) of the American Society of Mechanical Engineers' Blackall Machine Tool and Gage Award. The award was presented for a series of papers on high rate electrochemical machining. . . . **Dick Nathan** is now Associate Manager of the Organic and Structural Chemistry Section of Battelle Memorial Institute. The Nathans' second child, Daniel Scott, was born last March 7. . . . **Phil**

Hoover is in his last quarter at the naval postgraduate school in Monterey and plugging away on his thesis. (The "is" is as of last November). In January he leaves (left) for a three month Navigation School at Dam Neck, Virginia, and thence to the U.S.S. George Washington (SSBN 598) at Pearl Harbor. . . . **Bernie Nordman** is also with the Navy and reports he is plugging away and trying to figure out how anything ever gets done. . . . **Phil Smith** has been named financial director of the Brand-Rex Company, a manufacturer of wire and cable. . . . **Steve Snover** is working on the development of new junior high school mathematics curricula under a grant from the N.S.F. to the Physical Science Group at Boston University. . . . and **Steve Williams** has been named assistant vice president in the Finance and Planning Division of the American Stock Exchange. Steve's responsibilities are in the areas of operations research, planning, and control.

By now you will all have received the mailing on the tenth Reunion this June. I might add that we have reserved the Museum of Science in Boston for the Saturday banquet, and are still working on other details. Y'all come!! — **Steve Lipner,** Secretary, 3703 Stearns Hill Rd. Waltham, Mass. 02154

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It has been more than eight years since the first of us left the Institute and during these years I have noted with real interest the number of our class members remaining in school. It seems that for the first time since graduation I have received more news about careers and kids than about academic pursuits. However, special awards go to those die-hards who can rationalize still being in school, and real congratulations go to those who have just finished up. **David Haccoun** received his Ph.D. in E.E. from McGill University last June. . . . **Roger Rasmussen** received his Ph.D. in management from U.C.L.A. in August and is now working as a social scientist at the Rand Corporation. He is doing education and health care research. . . . **Woody Sullivan** received his Ph.D. in Astronomy back in 1971 at the University of Maryland but managed to spend two more "very enjoyable" years in Holland in a post-doctoral position at the University of Groningen. He now teaches in the Department of Astronomy at the University of Washington. . . . **Peter Lobban** is back at Stanford to take an M.S. in electrical engineering with the hope of going into medical electronics. . . . **Stephen Shapiro** has just completed his first two years at the University of Pennsylvania in Medicine and appears to be looking forward to the remaining two. He spent the summer working and studying at the hospital at Huntsville Prison in Texas. . . . **Tom McNelly** received his Ph.D. in Physics from Cornell last June and has joined the staff of G.E.'s Corporate Research and Development Center in Schenectady. . . . **Bill Nelson** writes that "after being in the midwest for six months we are beginning to long for the east coast. Maybe we will even get to New England again after this post-doctoral program."

It is obvious that the class has moved from the academic years into the years of procreation. . . . **Joel Pearlman** reports that after school he was married to his wife Marianne and they now have a daughter named Heidi. He works as an electrical engineer for the DOD. . . . **Don Schwanz** and his wife Mary were "blessed with our first child, a girl, Krista Holly, on 1 October." . . . From **John Golden:** "My wife Carolyn and I recently had our fourth child, Mathew Benjamin. He joins two sisters and one brother. I am currently working at Polaroid as the Manager of Production Planning and Control. My spare time is spent pursuing my hobby of flying both land and sea planes." . . . **Mark Yogman's** second son was born this past year. . . . **Donald Haney** is now a captain in the air force at Randolph Air Force Base. His second son was born last fall. . . . **Dave Vanderscoff** and his wife Elaine had their second child last winter. Their daughter is nearly seven. He has changed jobs after seven years with New York Life Insurance Co. and now works for Manhatten Life Insurance Co. as an associate actuary. . . . **Daniel Smith** writes "we now have a two month old son named Joshua. He is uniquely enchanting and I have no doubt that a detailed account of all he is doing would be endlessly fascinating to your readers. I have firmly resolved to finish my degree before MacDonald's sells two billion more hamburgers." We will check in on Dan in two years to see how he is doing on that degree. He may be among the super all-time awards at the tenth reunion! . . . **Bill Cain** reports that he and his wife Britt took a trip to Egypt, Iran, and Israel this summer and liked Iran by far the best. He is now teaching finance and quantitative methods at Emory University. . . . We have a report that **Jon Meads** is alive and well in Portland and is currently terrorizing the Northwest Rugby Clubs under the assumed name of TROLL. . . . **David Carrier** along with his wife and daughter are living in San Francisco and loving every minute of it.

Art Boyars writes that "by the time this appears in *Technology Review* my wife Jan and I will have taken the great bourgeoise step forward into our new house." Little does he know. By the time this appears he will have sold the house! . . . **Michael Leavitt** has spent a year doing research at CACI, Inc. in Arlington, Va. after three years as an assistant professor at the University of Wisconsin in Madison. He is now director of the Social Science Computation Center at the Brookings Institute in Washington. . . . **Jack Fuhrer** has worked for the past four years at R.C.A. Labs in Princeton as a member of the technical staff and has been involved with the selectavision project. He and his wife Susan have three children. . . . **Martin Kaliski** is an assistant professor in the Electrical Engineering Dept. at Northeastern University. . . . **William Nelson** has left the University of Delaware and their Solar Energy Program last fall and has moved to Columbus Ohio where he is now at the Battelle Memorial Institute. . . . **James Kester** has bought a house at Offutt Air Force Base where he has met several alumni. . . . **Paul Kebabian** is presently working for Environmental Research and Technology, Inc. of Concord, designing instrumentation for the real time measurement of pullutants. . . . **Lawrence Kilham** is presently working for Boston Export Sales Inc. in Waltham Mass. developing markets for Route 128-type high technology products in Latin America.

Brian Schumacher is working happily and permanently now in the bay area of San Francisco for Thomas Lunde, Inc. They are a small company specializing in naval architecture and marine and rail vessels. . . . **John Esterl** is presently serving as a nuclear ship superintendent at Mare Island Naval Shipyard. He is "delighted to have returned to the San Francisco area." . . . **Thomas B. Jones** has been promoted to Associate Professor of Electrical Engineering at Colorado State University. They have a new daughter born this last August. . . . **Donald DeAngelis** is currently on the research staff of the Environmental Sciences Division of Oak Ridge National Laboratory working on models of ecological modeling and theory. . . . **Brian Schultz** received the title of "senior power engineer" this past spring with Stone and Webster. He is currently a project engineer on their Standard Nuclear Power Plant Project. . . . **Rodger Thompson** has been promoted to associate professor in the Department of Astronomy and an associate astronomer at the Steward Observatory at the University of Arizona. Well troops, back to wrapping Christmas presents . . . keep me in mind when you're writing letters on those cold February nights. — **Tom Jones,** Secretary, 59 Commercial Wharf, Boston, Mass. 02110

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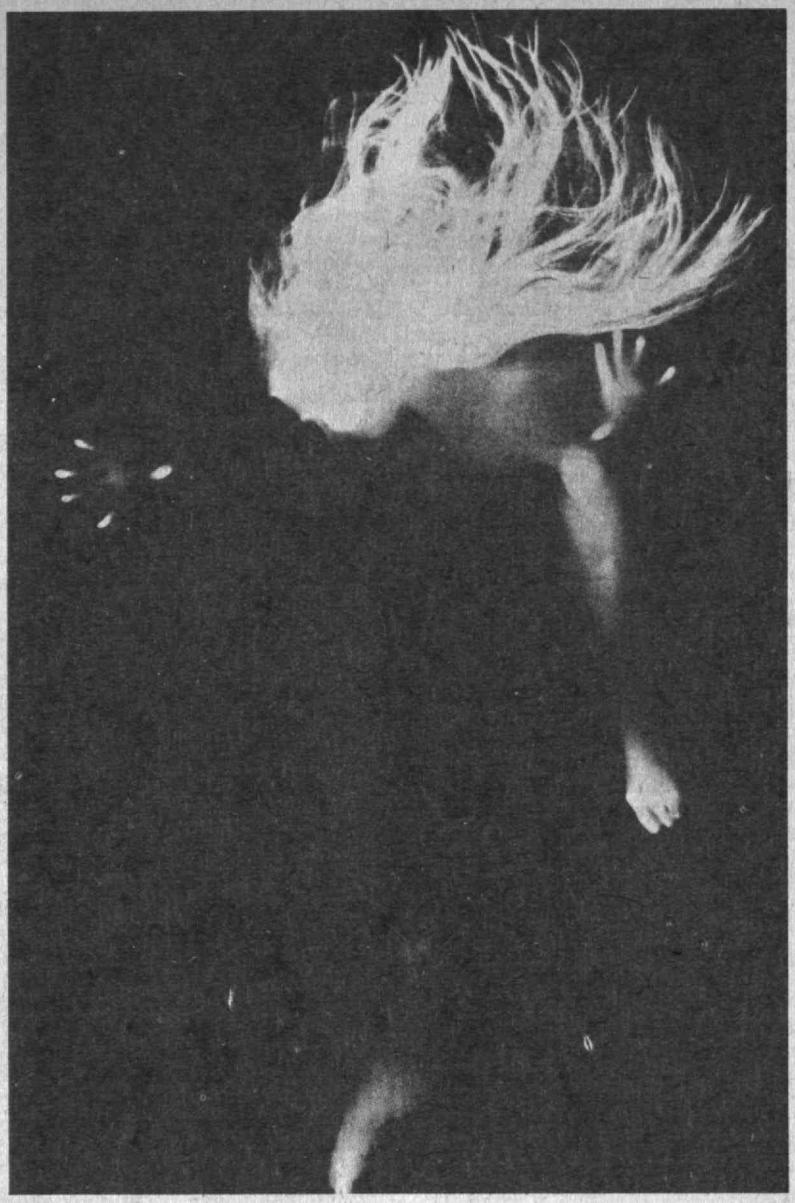
Sorry about missing the column last month. We took a one month vacation in Japan in the Fall and fell behind in things for a few weeks after we got back. We had a great trip as the weather was pretty good and most of the masses of Americans had gone away. We travelled from Tokyo to Ibusuki on the southern tip of Kyushu and back by way of every conceivable means of transportation: bus, train, plane, ferry, and hovercraft. We spent a pleasant afternoon in Tokyo with Chuzu Takahata (SM Course 22) who showed us around town. Japan need not be as expensive as some articles tell you, but it is also very easy to end up spending astronomical sums. But now on with the news. . . . We got a long note from **Ellen (Colmer) Domb.** She received a Ph.D. last spring from Temple University while her husband, Bill, finished dental school. Upon graduation, the Air Force sent Bill to Omaha and Ellen was able to get a postdoc at the University of Nebraska, 55 miles away. She teaches a course in the math department, has recitations in the physics Department, and does research in the Electronic Structure and Magnetism Lab. They are having a great time starting flying lessons and write, "Being out of school, flying, breathing clean air, all fantastic!" They welcome visitors and point out they live only three minutes from Interstate 80.

We have two births to announce this month. **Dave Seldin** wrote to announce that Jeffrey Alan was born on June 14. Dave is in his final year of medical school at N.Y.U. and will start a residency in Radiology in July. He is looking forward to moving out of Manhattan and starting to earn a living. . . . **Ron Bohm** writes that his second son, Stuart Marshall, was born on April 21 and has a full head of hair — all cowlick. The family is living in Miami where Ron works for the Knight Newspapers. . . . We also have two new doctorates to announce this month. **Jack Bowie** "finally" received an Sc.D. in E.E. in September 1973 and is working at the Laboratory of Computer Science of the

Mass General. . . . **Robert Moore** received a Ph.D. in math from Indiana University in August 1974 and now has a three year appointment as an Assistant professor at Bucknell University where his wife, Pat, is working in the computer center. . . . Having spent a year at the Brookings Institution in Washington, **Barry Mitnick** has moved on to Ohio State University where he is an assistant professor of public administration and political science.

We have two notes this month from the medical contingent of the class. **Richard Handler** is a resident at Albany Medical Center Hospital, Albany, N.Y. He reports still being very interested in bicycling, cross country skiing, and sailing Hobie Cats. . . . **Paul Gluck** is a second year resident in OB-GYN at the University of Miami-Jackson Memorial Hospital where his wife, Joan, is a fellow in allergy and immunology. He recently presented a paper at the District IV meeting of the American College of OB-GYN entitled "Leprosy in Pregnancy — The Immunologic Implications" and was awarded first prize in the Junior Fellow Competition. . . . Pam and **Scott Marks** recently moved to New York where Scott has joined McKinsey & Co., a management consulting firm. While they miss Bean town, they find New York very exciting. . . . **John Kasarda** has been named Vice President of Engineering Computer Systems of Lexington and Manager of their New York office. The company specializes in the development and installation of business oriented systems for mini-computers. . . . It may not be a surprise to you, but **George Phillies** is still at the 'tute. He's now an O.S.P. (formerly D.S.R.) staff member in the Harvard-M.I.T. Health Sciences and Technology Program. While the number of classmates around M.I.T. has stabilized, he reports still bumping into **Gerry Sussman,** Bill Hsu, '67, and Elaine (Lancaster) Thomas, '67.

Rick Rudy is now a Senior Manufacturing Engineer with G.E.'s Nuclear Engineering Division in San Jose. He spent his vacation time last summer camping in Lassen Volcanic, Yosemite, Grand Canyon, Bryce, and Zion National Parks. Finding Gilbert and Sullivan groups wherever he moves to, he has appeared in two productions and is now directing *Trial by Jury*. . . . **Don Bruns** is now living in San Francisco as a result of a job transfer. He writes, "Loving California weather and ocean. This is absolutely a great place for weekend outings. A winter in San Francisco is much better than a winter in Chicago. . . . From Durban, South Africa we hear that **Paul Forbes** is working for the construction firm of Dorman, Long and has remained a bachelor. . . . The Enviromental Protection Agency has transferred **Jan Sinnett** from their headquarters to the National Marine Water Quality Laboratory in Narragansett, R.I. His new job involves the design and implementation of electronic systems for laboratory experiment monitoring and control. . . . **Gary Johnson** is now teaching math at the Air Force and meeting with the Fellowship of Christian Athletes. . . . Having been released from the Navy in May, **John Niles** now works as a program analyst in the Budget Office, District of Columbia City Government. . . . **Terry Vander Werff** '66, is now Chief Bio-Engineer and head of the biomedical engineering program at Groote Schuur Hospital and the University of Cape Town Medical School in Cape Town, South Africa. . . . **Tom Brosterman** is an assistant professor in the Department of Art, U.C.L.A. He has been experimenting with non-optical photography and the use of early photographic emulsions. Together with his wife, **Ronnie,** as a model he has developed a new technique for striking, somewhat abstract photographs and recently held a show at the Alfred Stieglitz Gallery in New York. . . . That's all for this month. Keep those cards and letters coming, folks. — **Gail** and **Mike Marcus,** Class Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22043



A portrait of Ronnie Brosterman, '68, by her husband, Tom, '68, from his exhibit, "Non-Optical Photography" at the Alfred Stieglitz Gallery in New York City.

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Bruce D. Glabe has been awarded first year honors at the Harvard Business School where he is now in the second year of the two-year M.B.A. program. Before entering the business school, he was a city auditor in Somerville, Mass. . . . **Ronald L. Yin** has joined R.C.A. as a member of the patent staff of the David Sarnoff Research Center in Princeton, N.J. Subsequent to this graduation from M.I.T., Ron received his M.S. degree in applied physics from Cornell University in 1971 and his J.D. degree from Georgetown University in 1974. . . . **Stephen A. Hill** has won the $100 second prize in the 1974 Nathan Burkan Memorial Competition at the Franklin Thomas Backus School of Law at Case Western Reserve University. The competition is sponsored annually by the American Society of Composers, Authors and Publishers and is designed to stimulate interest in the field of copyright law. The title of Steve's winning essay was "State Protection of Intellectual Property: The New Limits and Their Effects." Steve is now an associate with the Cleveland law firm of Bosworth, Sessions & McCoy. . . . **Alan J. Grodzinsky** has been appointed an assistant professor in the department of electrical engineering at M.I.T. for three years beginning July 1, 1974. . . . **Joel I. Seiferas** has been appointed an assistant professor of computer science at Pennsylvania State University. . . . **Ronald L. Bagley** and his wife are living in Great

Falls, Montana "courtesy of the U.S.A.F." where Ron is an electronic warfare officer flying EB-57 Canberra jet bombers. Ron and Ellen have two children, Ross, two and a half years, and Melissa Anne, one year old. . . . After finishing his S.M. at M.I.T. in 1970, **Larry Hodes** worked for a firm in the Boston area. In the fall of 1972, he returned to school in Chapel Hill, N.C. and picked up his masters degree in social policy planning in May 1974. He is now living in Raleigh, N.C., working for the North Carolina State Planning Office as a policy analyst. . . . **Michael W. Laird** is still working for Cummins Engine Company. He had the good fortune to spend a month in Europe for his employer early in 1974 where he performed research for a strategic planning project and visited all of his employer's European locations and eight competitor's operations. He is now in charge of a department that is responsible for material planning, purchasing, specifications, and computer system design for a worldwide distribution center of service parts.

Alan S. Ratner is employed by the Defense Department in the Washington, D.C. area and is living in the new city of Columbia, Md. . . . After working in his major field of nuclear engineering for five years, **George T. Hamilton** has transferred to general management in the non-destructive testing industry with Conam Inspection located in northern New Jersey. . . . On August 24, 1974, **Carol Scott** married Harry F. Conner, a graduate of Princeton University and now a student at New York University Medical School. At the time of writing, they were living in a room in a dorm at N.Y.U. but were planning to move into a new building located next to Bellevue Hospital. Carol is in her third year at N.Y.U. Medical School and is serving a surgical clerkship at Bellevue Hospital. She finds "surgery much more fun than I expected - but a lot of hard work! It's good to be on the wards and working with patients and using my hands again after two years of classes and labs." . . . **Thomas Dooley** is a force structure officer with headquarters 59th ordnance group in Pirmasens, West Germany. His son Brook was born in April 1974. . . . The **Viehlands,** Larry and **Kim (Winters),** have a new son Jeremy. Kim is teaching college algebra while Larry is engaged in post-doctorate work at Brown University anticipating an assistant professor position this coming fall. They report that **Peter Meschter** is now a Ph.D. in metallurgy and is in West Germany for post-doctorate studies. . . . **George Flynn** is currently working towards his Ph.D. in physics at Washington University in St. Louis, Mo.

Mel Basan passed the Massachusetts state bar examination in 1974 and is now working with a management system design firm located in Wellesley, Mass. . . . After finishing his fourth and final year in the U.S. Army, **Robert G. McGregor** was looking forward to obtaining some formal education in urban management beginning this coming fall. Bob hopes to spend this summer travelling through Eastern Europe as a "final fling." . . .**Peter N. Zacharias** received his M.B.A. from Harvard Business School in June 1974 and is now working for his family's small manufacturing business located in Reading, Penn. . . . **Richard Wolfson** graduated from Swarthmore College in 1969, received his M.S. in environmental studies from the University of Michigan, taught school for two years, and is now working toward his Ph.D. in physics at Dartmouth College. He says "hello to everyone." . . . **Richard Wallin** writes that he and his catfish have settled much too comfortably in Amherst, Mass., where he is working towards his Ph.D. in educational psychology which he says is "beginning to seem an unending endeavor." Dick recently ran into **Bob Leet** who has built himself a house in the woods near Amherst. Bob is now off "wintering" in California. . . . I hope to be hearing from you soon! — **Richard J. Moen,** Secretary, 4008 IDS Tower, Minneapolis, Minn. 55402

The new '69 officers are: President: Laura Miller Peterson, 131 Patterson St., Bedford, Mass. 01730; Vice President: Thomas Najarian, 193 Lewis Rd., Belmont, Mass. 02178; Secretary/Treasurer: Peter Peckarsky, 950 25th St. N.W., #402, Washington, D.C. 20037; Class Agent: Melvyn Basan, 114 Stratmore Rd., Brighton, Mass. 02146; Executive Committee: Carolyn Gissen Dedrick, 12 Park St., Brookline, Mass. 02146; Shelley Fleet, 7620 N. Eldorado St., #303, Stockton, Calif. 95207; Maria Kivisild Ogrydziak, 72 Standish St., Cambridge, Mass. 02138.

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Bob Haworth writes, "I am now completing my last year in three on a training program with Honeywell's Major Computer Plant in Phoenix. I have gotten a Master's in E.E. from Arizona State University and am still dating Nan Robinson (would have been class of '75) who is taking pre-med at A.S.U. . . . **Joe Clift** says that he is enrolled in the Stanford M.B.A. Public Management Program. "I miss Cambridge — Palo Alto isn't quite the same. The program is really great."

A few short notes . . . **Ernesto Murillo** is working in Colombia, advising the Department of Planning on Transportation. . . . **Fred Fruitman** is at the University of Toronto Law School, having returned from two years in England where he got a law degree from Oxford. . . . **Cynthia DuPont** is working in the Opera Company of Boston in a number of capacities, including chorus. . . . **Don Seltzer** has been working in Industrial Automation at Draper Lab for the last two years and was married in September to Ann-Marie-Resch (Emerson '73). . . . **Lewis Jester III** will be graduating from the Harvard Business School. . . . **David J. Beck** and **Vincent Tobkin** are also at the B. School. . . . **Virginia Clark** received her Master's in the Yale Geology and Geophysics program last year. . . . **Byron Miller** was recently promoted to Assistant to the President of the Wallerstein Company, a division of Baxter Laboratories. . . . **Shelden Jay Price** has moved to the University of Virginia graduate school. . . . **Jim Roxlo** writes that he is alive and well working for DuPont in Wilmington and spends his time sailing and playing tennis. . . . **Bruce Schwartz** is at Law School. . . . **Thomas DiPrete** is working toward a Ph.D. in sociology at Columbia.

Terrill Chang reports, "I have opted to stay in rain country. I finished my M.S. and am now a Mechanical Engineer with CH2M-HILL, a consulting company in their Bellvue, Washington office." . . **Allan Kirkpatrick** is back in Cambridge and has replaced **Shabbir Nomanbhoy** at Scientific Energy Systems in Watertown analysing the performance of their steam engine. . . . Shabbir, incidentally is travelling through Europe and was in Paris through Christmas. From Rome he wrote, "It is a magnificent city. St. Peter's is just too awe inspiring and Michelangelo a genius of no mean order. Today I went roaming around the back streets to find the spot where old July stained the streets."

Michael Kotch writes, "I am in Los Angeles with two cats in the yard and four more in a recent litter. I have moved from bombers to the space shuttle where the work is heavy and my particular task (wind tunnel testing) takes me to numerous government facilities across the U.S. There are many challenges, both academic and personal." . . . **Robert Reiter** reports, "After two and a half years at the University of Maryland with G.T.A. I'm bypassing the M.S. in favor of a Ph.D. now that I've successfully (and finally) completed my comprehensive course work and examinations in computer science. Hope to have a dissertation topic by May. Still trusting in the Lord Jesus (and still single,)." . . . **Richard Eckert** has graudated from Air Force navigator training Mather A.F.B., Calif., where he is remaining. Happy Groundhog day to you all. — **Dick Fletcher,** Secretary, 135 West St., Braintree, Mass. 02184

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Well, how do I start off? I don't know, maybe I'll just continue. I have heard from **Richard Parker.** He is a graduate student in Biology at the California Institute of Technology (weird name for a school, isn't it). He says that **Will Wheatley** and **Bob Collier** are also attending there. Bob is now married — to Patricia Mooney. Richard writes us, "Life in Pasadena is dull and Cal Tech is very different from M.I.T." . . . Another in California is **Lionel Goulet,** who writes, "I'm living and working in California where an M.I.T. degree means something. They don't know any better out here I guess." . . . And a third classmate in California — this must be the month for California — **Richard Granstein,** who writes, "I am a student at U.C.L.A. Medical School, working hard. I'm thinking somewhat about applying to an M.D.-Ph.D. program, but don't have to decide for awhile." And that is the last of the California correspondents for this month.

Dave Gromala is in Illinois and tells us, "I'm presently enrolled in graduate school at Northwestern University. My state of finances is atrocious. Don't worry Dave, soon everyone's finances will be atrocious. . . . Now a little from the Cambridge-Boston area contingent. **John Hixson** is working for the Cambridge Transportation Forum — an advisory board to the City Council made up of Cambridge citizens. . . . **Tom Vasak** is working as a programmer for the Boston University Medical Center. . . . And myself. In addition to school, I'm working part-time as a transportation planner for the Cambridge Community Development Department. — **Dennis Dickstein,** Secretary-Treasurer, 23 Howard Street, Cambridge, Mass. 02139

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